COMMISSION DE LA CARTE GÉOLOGIQUE DU MONDE
COMMISSION FOR THE GEOLOGICAL MAP OF THE WORLD

BULLETIN 53

2003-2004

Resolutions of the General Assembly
Florence, Italy – 23-24 August 2004

SECRETARIAT

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COMMISSION FOR THE GEOLOGICAL MAP OF THE WORLD (CGMW)

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FOREWORD

During our General Assembly held on the occasion of the 32nd International Geological Congress in Florence, the assessment of our mapping activity showed that two types of projects are being carried out concurrently within our Commission. Some of them come to an end in the short term and their targets are regions or very specific themes; on the contrary, others involving global or continental mapping, require more time for their achievement. An original experiment was thus carried out during the last four years 2001-2004. During the 31st IGC in Rio de Janeiro, six new mapping projects were launched with a view to having them published on time for the Florence IGC. For two of them, their geographic frame was the Mediterranean and surroundings – theme of the 32nd IGC– and responded to the demand of the IUGS and IGC. These maps, which are commented further in this issue, are the following: the *Geodynamic Map of the Mediterranean* (2 sheets); the *Maps of the Mediterranean environments during the last two climatic extremes (2 sheets, Last Glacial Maximum and Holocene Optimum)*; *Map of the Indian Ocean*; *Map of the Metamorphic Structure of the Alps*. Within four years, the concerned teams were led to elaborate a scientific rationale in order to define the ideas and objects whose representation was to be favoured and finally to ensure the graphic expression of these mapping concepts. As a result of the strong mobilization of the teams, these maps were completed in the time allowed and their publication was made possible thanks to the sponsoring obtained from several European universities and scientific institutions.

The discussions we had with the participants to the sessions of our General Assembly and the visitors of our stand at the 32nd IGC, as well as with the participants to the T-12.01 Symposium "Earth imaging: modelling and databanks. A prospective for the 21st century after more than a hundred years of mapping experience" strengthened the idea that CGMW geoscientific maps are perceived by our community as true scientific products and not as mere compilations of data gathered on a common basis. As scientific publications, these maps are centred around a concept, a theme, and highlight a set or sets of phenomena that their author/project manager chooses to represent. In a way, because they convey ideas, one can say that these maps are drawn up and not only assembled or coordinated.

By displaying images of the progress in science, CGMW maps participate to the Geoscience research. Their success among educational institutions proves that the way we follow is a fertile one.

AVANT PROPOS

Lors de notre Assemblée Générale à l'occasion du 32ème CGI à Florence, le bilan de notre activité cartographique a montré que deux types de projets sont menés concurrement au sein de note Commission. Les uns sont réalisés sur un très court terme avec pour objectif des cartes ciblées sur des régions ou sur des thématiques très précises. Les autres d'échelle continentale voire mondi ale nécessitent plus de temps pour leur réalisation. Une expérience originale a ainsi été menée durant les quatre dernières années 2001-2004. Lors du 31ème CGI à Rio de Janeiro la mise en chantier de 6 nouvelles cartes destinées à être publiées pour le CGI de Florence avait été décidée. Deux d'entre elles, ayant pour cadre la Méditerranée et ses abords -thème central du 32ème CGI- l'étant à la demande de l'IUGS et du CGI. Ces cartes, brièvement commentées plus loin dans notre bulletin, sont les suivantes : Carte géodynamique de la Méditerranée *(2 feuilles);* Carte des environnements méditerranéens pendant les deux extrêmes climatiques *(2 feuilles : dernier maximum glaciaire et Holocène optimum);* Carte de l'océan Indien*,* Carte de la structure métamorphique des Alpes*. En quatre années, il a donc fallu aux équipes engagées : assurer une réflexion scientifique pour définir les idées et les objets dont on voulait privilégier la représentation et enfin assurer l'expression graphique des cartes. Ces cartes ont pu être réalisées dans le délai imparti grâce à la très forte mobilisation des équipes de projet mais leur impression n'aurait pas pu être réalisée sans le mécénat de plusieurs universités et institutions européennes qui a permis de les financer.*

Les nombreuses discussions que nous avons eues lors de notre Assemblée ou avec nos visiteurs sur notre stand au 32ème CGI ou bien encore lors de la session CCGM T-12.01 "Earth imaging : modeling and databanks. A prospective for the 21st century after more than hundred years of mapping experience" confirment que les cartes géoscientifiques sont bien perçues par notre communauté comme des données scientifiques et non des compilations de données réunies sur une base minimum commune. Comme les publications scientifiques, elles s'articulent autour d'un concept, d'une thématique et mettent en relief un ou un ensemble de phénomènes que l'auteur/chef de projet a privilégié de représenter. En ce sens, et parce qu'elles véhiculent des idées, on peut dire qu'elles sont rédigées et non pas seulement assemblées ou coordonnées.

Les cartes de la CCGM en présentant des images de la science en marche, participent ainsi à la recherche en Géosciences. Leur succès auprès des organismes d'éducation et d'enseignement montre que la voie suivie est fertile.

Philippe Rossi
Secretary General

Paris, April 2005

In memoriam: Henri Kampunzu (1952-2004)

Professor Ali Basira Henri Kampunzu passed away on Monday, 29 November 2004 at the Midland Park Hospital in Johannesburg (South Africa) and was laid down to eternal peace on Monday, 06 December 2004 in his home country in Kinshasa (Democratic Republic of Congo, DRC). He was a well-known and greatly acknowledged trilingual African geoscientist. Some argue that he was the best-known and the greatest African geologist of our time. The late Henri participated in more than a hundred international geological conferences on four major continents (i.e. Africa, America, Asia and Europe), and organized more than twenty international geological conferences in Africa and Europe. He was invited as a keynote speaker to more than forty major international conferences.

Henri was born in Bukavu town (eastern DRC) on 27 November 1952. He was the second of six children in his family. He began his primary education in 1958 and proceeded with secondary education (1964) at the Athenee de Bagira in the same hometown. Besides other general secondary school subjects, this school specialized in biology and chemistry. Thus, it seems that this school correctly predicted his scientific future at that tender age. Henri ended up being an excellent geochemist and petrologist of undoubted international repute. We vividly recall his moving seminal lectures which were characterized by discrimination diagrams and geodynamic models based on abundant and unequivocal chemical and isotope data. Henri joined the "Ecole des Mines" (ENM) in 1970 to attend a pre-university training in geosciences. Later on he joined the University of Lubumbashi and passed with a "high distinction" for his MSc degree in geology ("licence" in geology). He obtained a "highest distinction" for his PhD in petrology from the same university in 1981. Henri began his university career at the University of Lubumbashi as an assistant and rose quickly up to the ladder of a professor in 1983. He spent two short spells during his academic career at the University of Aix-Marseilles III (France) as a visiting professor (1981-83 and 1986-88), and as from 1996 to the time of his demise was a professor at the University of Botswana. Henri Kampunzu supervised more than forty MSc dissertations at the universities of Lubumbashi, Marseilles and Botswana. He did the same for more than twenty PhD dissertations at the universities of Lubumbashi (DRC), Marseilles, Nancy, Brest (France), Wits (South Africa), Botswana and Osaka City (Japan). He was invited to give special courses and seminars to post-graduate students of several universities in Africa (e.g. in Congo-Brazzaville, Senegal, Togo, Zambia) and Europe (e.g. Montpellier, Clermont-Ferrand, Brussels and Braunschweig). He also acted an external examiner for several universities in Africa and Europe. Due to his deep insight into the geology of the "Copperbelt" of the central African region, he trained geologists from exploration and mining companies working in that area. He was also engaged in some consultancy work, mostly for companies aiming to develop the mineral resources of his home country and neighouring Zambia.

Henri Kampunzu had time and patience and was exceptionally helpful to his students. He was an excellent academic guardian and partner for both young and old colleagues. He had great vision and a mission insofar as the development of earth sciences in Africa is concerned. He single-handedly established the Laboratory of Petrology for the African Geology in 1980 at the University of Lubumbashi but due to the endless wars and subsequent destabilizing factors in his home country, he was forced to seek employment at the University of Botswana in 1996. On his arrival in Botswana, he immediately started giving the Department of Geology an international recognition and statue. He served on several faculty committees, supervised students' research projects, and became the coordinator of the well-equipped geochemical laboratory of the department. Henri was a prolific scientific writer, enthusiastic and took time and patience to assist his students and colleagues in preparing high-quality papers for publication. Most of his younger colleagues (e.g. Francis Tembo, Zambia and Estella Atekwana, USA) regarded him to be their greatest mentor in academia. Thus, he was always a very optimistic person who believed in overcoming all sorts of scientific hindrances facing the poorly funded and ill-equipped African earth science institutions.

Henri Kampunzu, the Fellow of the Gondwana Institute of Geology and Environment, was a dynamic, innovative, productive and ambitious scientist. At the time of his death, he was engaged in about ten major international geological projects with subjects falling in the Archaean to Phanerozoic age-range. He published over one hundred (100) papers in peer refereed journals, over fifteen (15) chapters in geological books, and co-edited two geological books. He had more than a hundred abstracts published in international conference proceedings. Due to his great skills of writing scientific papers, efficiency and in depth knowledge on the geology and mineral resources of Africa, Henri Kampunzu was appointed in 2002 to be one of the two Editors-in-Chief of the Journal of African Earth Sciences (JAES), Regional Editor (Africa) for the Gondwana Research journal (1998), Associate Editor (Africa) for Episodes (1998), and Regional Editor (Africa) for Chronicle of Mineral Research and Exploration (BRGM, France). He was greatly involved in the preparation of the Geology and Major Ore Deposits map of Africa at the scale of 1: 10 million which was published in June 2004 in conjunction with the 20th Colloquium of African Geology (BRGM, France). One of his major recent geological undertakings was the production of the Rodinia map which is being done under the tutelage of IGCP 440. He was a co-leader of two highly successful IGCP projects (Numbers 227 and 440) whose ranking by the UNESCO-IUGS-IGCP scientific board was either "excellent" or "very good". Henri served this very important world body (1996-2000) and became chairman of its Working Group 4 (Geophysics, Tectonics and Structural Geology) in 1998.

One would wonder if Henri had time left for his family! He was strongly supported by his wife (Pacifique) and their son (Jonathan) who are used to receiving many guests at their residence in Gaborone (Botswana). It was not surprising to find Henri busy in the kitchen helping his wife prepare the always delicious dishes for the guest of the day – this is not typical African culture but he performed it with his usual great humour and charm! Being a Congolese, Henri enjoyed listening to music and occasionally danced to the best tunes. His favourite château red wines would certainly be served to his guests when taking the meals at his residence. The first time I personally experienced Henri's generosity and true African brotherhood was in 1989 in Rabat (Morocco) during the geological conference organized by the Geological Society of Africa (GSAf). Some of our African colleagues who came directly from their home countries had no money (foreign currency) for their meals and drinks. Henri did not hesitate to use his credit card to defray the costs that his colleagues had incurred in the hotel. He believed and practiced democracy, and was one of the key members of GSAf who persistently fought for a democratic statue for the society. A testimony to this assertion may be traced back to his presidency to the trade union of academic staff at the University of Lubumbashi (1992-96).

The demise of Prof Henri Kampunzu has brought geologists around the world into deep mourning, anguish and untold sorrow. This bereavement that struck Africa is expressed by the poem titled, **"Kampunzu vanity of vanities":**

"Who called Kampunzu in the past tense?
Library shelves tell the story
Dust on any Kampunzu never seen
The journals finalize it all
Died in haste, leaving knots unfastened
Leaving hypothesis without theories
Kampunzu the perfect future"
"Oh Kampunzu, the contemporary genius
How will conferences run without you?
Who will translate with parrotic rhythm?
Brilliant keynote speeches never again
Nor the chairing of Mesoproterozoic and Rodinia
Geologists, immortalize Kampunzu
For him to live and die no more"
(Dr. Isaac K. Njilah, Yaoundé, Cameroon)

Henri was a very serious and committed scientist who believed in sharing knowledge, skills and research facilities. Consequently, he was a member of several professional societies and associations. He joined the Geological Society of Africa in 1981, the Canadian Associations of Mineralogists (1981) and Geologists (1981), the Societé Géologique de France (1981), the Societé Géologique de Belgique (1981), the Geological Society of Zambia (1987), the Botswana Geoscientists Association (1997) and the latest one was the Geological Society of Australia (1998). He also was a member of AGID, INQUA, and other scientific bodies. Henri took a leadership role in some of these bodies, for instance, he was the Vice President of GSAf in charge of the central African region (1985-90), Chairman of the International Commission for Earth Sciences in Africa (ICESA) which is affiliated to ILP. One of the recent tasks of ICESA is to update the geology of Africa through publication of a number of volumes in a chronological order. This work is just beginning and has to be completed. Those involved in this paramount homework have to mimic Henri's scientific ambitions and inspiration to accomplish it. Henri, Fellow of the Geological Society of Africa will be watching us and as D.H. Lawrence (1885-1930) wrote to J. Middleton Murry on 02 February 1923, **"the dead don't' die, they look on and help."**

In conclusion, we can say that the late Professor Henri Ali Basira Kampunzu, Fellow of the Third World Academy of Sciences (TWAS) lived a short but exciting life full of achievements and has thus, left behind an enviable scientific and professional record. He was an outstanding scholar of very high calibre who could publish an average of five papers in different international journals in one year! Professor Peter Bowden who twenty (20) years ago interpreted the presentation of Henri from French into English at the 13th Colloquium of African Geology which was held at the University of St. Andrews (UK) acknowledges that Henri was a talented person. He quickly grasped scientific English and thus, did not request Peter Bowden to continue interpreting his manuscripts into English. Henri had the capacity, the will and was pragmatic in learning new techniques and skills as evidenced by his involvement in the remote sensing and GIS research project of Professor Tsehaie Wodai (ITC, The Netherlands) where he quickly learnt, understood and applied the spatial modeling and mobile computation of earth science base data in inaccessible formats. It is indeed correct when Tsehaie called him the "guru" and the greatest giant of the African geology. Prof Kampunzu dedicated much of his time on research and development of earth science in Africa. Mr. Joshua Tuhumwire, the Director of the Geological Survey of Uganda gives us this closing statement, "Henri worked so hard on this earth and I believe that the other side of the world he has gone to was so jealous of Africa and grabbed him sooner rather than later." Henri replies by saying, "***Non omnis moriar – I shall not altogether die"*** *(Horace, 65-8 BC).* Professor Henri Ali Basira Kampunzu rest in perfect and eternal peace (Amen).

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(with acknowledgements to Boneza T. Rumvegeri, all those mentioned in the text, and to all who conveyed condolences to Henri's family and GSAf)

GENERAL ASSEMBLY / *ASSEMBLEE GENERALE*

Florence, Italy

August 22 – 23, 2004

CGMW GENERAL ASSEMBLY

Plenary Sessions Room N° 34 – Congress Center

Florence, 22 and 23 of August 2004

P R O G R A M M E

AUGUST 22, 2004	MORNING	PLENARY SESSION
09:00 – 09:30	Report of the Bureau Meeting by the President and Secretary General	
	REPORTS OF CGMW VICE-PRESIDENTS IN CHARGE OF CONTINENTAL SUBCOMMISSIONS	
09:30 – 09:45	– **Europe**: F. Wellmer • IGME 1:5 M: K. Asch.	
09:45 – 10:00	– **Asia:** • The Geological map of Asia : Ren Jishun	
10:00 – 10:15	– **Antarctica :** G. Leitchenkov • Structural map of Antarctica • Tectonic Map of the Earth's Polar Regions (International Polar Year (IPY) Science Plan)	
10:15 – 10:30	– **Northern Eurasia**: O.V. Petrov • Overview	
10:30 – 11:00	**BREAK – POSTER SESSION OF MAPS AND DISCUSSION**	
11:00 – 11:30	– **Africa**: N. Frick, J. Sougy • The Tectonic Map of Africa, G. De Kock and J.-C. Guézou. • Sismotectonic and Lithologic maps of Africa, N. Frick	
11:30 – 11:45	– **Middle-East**: A. Haghipour • The Geological Map of the Middle East (2nd edition)	
11:45 – 12:00	Geological Map of the World, P. Bouysse	
12:00 – 12:15	Educational publications, P. Rossi	
12:15 – 12:30	Report of the Financial Committee, F.W. Wellmer	
12:30 – 13:45	LUNCH BREAK	
	REPORT ON THE ACTIVITY OF THEMATIC SUBCOMMISSIONS	
13:45 – 14:15	– **Tectonic Maps**: • Tectonic Map of Asia, I. Pospelov • Tectonic Map of South America, U. Cordani and V. Ramos	
14:15 – 14:30	– **Geodynamic maps:** M. Pubellier	
14:30 – 15:30	– **Metallogenic maps**: E. Hammerbeck • Metallogenic Map of South America at 1:5 M, E. Zappettini • World Large & Superlarge Mineral Deposits Map at 1:25 M, Pei Rongfu • Middle East Metallogenic Map, S. A. Aghanabati • Submarine resources Map, Pei Rongfu • Prospective of the development of metallogenic maps, E. Hammerbeck	
15:30 – 16:00	– **Metamorphic Maps**: R. Oberhänsli • Metamorphic Structure of the East Mediterranean	
16:00 – 16:30	– **Seafloor Maps** • Marine geology updates: M. Munschy • Map of the Caribbean, Ph. Bouysse – P. Lyttle • New projects: North Atlantic and SW Pacific oceans	
16:30 – 16:45	**BREAK**	
16:45 – 17:15	– **Hazards maps** • Hazards map of the Andes, E. Zappettini	
17:15 – 17:30	– **Hydrogeological Maps** • World Hydrogeological Map (WHYMAP): W. Struckmeier	
17:30 – 17:45	– **DIMAS and Geoterm:** K. Asch	
17:45	END OF THE AFTERNOON SESSION	

AUGUST 23, 2004	MORNING	PLENARY SESSION
	Plenary and closing session	
9:00 – 10:30	Reading and approval of the resolutions	

RESOLUTIONS OF THE CGMW
GENERAL ASSEMBLY

RESOLUTIONS DE L'ASSEMBLEE GENERALE
DE LA CCGM

FLORENCE, ITALY – 32ND IGC

August 23, 2004

THE COMMISSION

1. **Thanks** the Organizing Committee of the 32nd IGC for its support for the preparation of the present General Assembly, and
2. **expresses** its deepest thanks to the Secretary General of the 32nd IGC for providing the best conditions and technical facilities for the holding of this General Assembly in Florence, and
3. **endorses** the appointment of the following new Bureau Members:
   - Dr. Kristine E. Asch, Program Manager, BGR, Germany, as CGMW Vice-President for Europe.
   - Prof. Henri A.B. Kampunzu from the University of Botswana as CGMW Vice-President for Africa.
   - Dr. Jean Pierre Milesi, Senior Scientist, BRGM, France, as Secretary General of the Subcommission for Africa.
   - Prof. Acad. Ren Jishun, Institute of Geology of the Chinese Academy of Geological Sciences, as CGMW Vice-President for South and East Asia.
   - Dr. Harsh K. Gupta, Secretary of the Department of Ocean Development of India as Secretary General for the Subcommission for South and East Asia.
   - Dr. Peng Qiming, Dept. of Science, Technology and International Cooperation of the China Geological Survey as Deputy Secretary General of the Subcommission for South and East Asia.
   - Dr. Oleg V. Petrov, Director General of the Karpinsky All-Russia Geological Research Institute (VSEGEI), St. Petersburg, as CGMW Vice-President for Northern Eurasia.
   - Dr. Sergey P. Shokalsky, Head of Department of Legends for Russian State Geological Maps, Karpinsky Russian Geological Research Institute (VSEGEI), St. Petersburg as Secretary General for the Subcommission for Northern Eurasia.
   - Dr. Chris Pigram, Geoscience Australia Chief of the Minerals and Geohazards Division in Australia, as CGMW Vice-President for Australia and Oceania.
   - Dr. Eikichi Tsukuda, Director General of the Geological Survey of Japan, AIST, as President of the Subcommission for Natural Hazards Maps.
   - Dr. Marc Munschy, Senior Research Professor at the Ecole et Observatoire de Physique du Globe – IPGS / Strasbourg, France, as Secretary General of the Subcommission for Seafloor Maps, and
4. **extends** its most sincere thanks to the BRGM (French Geological Survey) for its continuous and generous

LA COMMISSION

1. **Remercie** le Comité d'organisation du 32ème CGI pour son soutien à la préparation de la présente Assemblée Générale, et
2. **exprime** ses plus profonds remerciements au Secrétaire Général du 32ème CGI pour avoir fait en sorte que cette Assemblée Générale se déroule les meilleures conditions techniques pour à Florence, et
3. **nomme** les nouveaux Membres du Bureau suivants :
   - Dr. Kristine E. Asch, Directeur de programme au BGR (Service Géologique Allemand), Vice-Président de la CCGM pour l'Europe.
   - Prof. Henri A.B. Kampunzu de l'Université du Botswana, Vice-Président de la CCGM pour l'Afrique.
   - Dr. Jean Pierre Milesi, Expert du BRGM (Service géologique français), Secrétaire Général de la Sous-commission pour l'Afrique.
   - Prof. Acad. Ren Jishun, Institut de Géologie de l'Académie Chinoise des Sciences Géologiques, Vice-Président de la CCGM pour l'Asie du Sud et de l'Est.
   - Dr. Harsh K. Gupta, Secrétaire du Département Indien pour le Développement Océanique, Secrétaire Général de la Sous-commission pour l'Asie Sud et de l'Est.
   - Dr. Peng Qiming, Département des Sciences, de la Technologie et de la Coopération Internationale au Service Géologique Chinois, Secrétaire Général Adjoint de la Sous-commission pour l'Asie du sud et de l'Est.
   - Dr. Oleg V. Petrov, Directeur Général de l'Institut Karpinsky de Recherche Géologique de Toutes les Russies (VSEGEI), Saint-Pétersbourg, Vice-Président de la CCGM pour l'Eurasie du Nord.
   - Dr. Sergey P. Shokalsky, Chef du Département des Légendes pour les cartes géologiques de Russie, Institut Karpinsky de Recherche Géologique de Toutes les Russies (VSEGEI), Saint-Pétersbourg, Secrétaire Général pour la Sous-commission pour Eurasie du Nord.
   - Dr. Chris Pigram, Chef de la Division Mines et Risques Naturels de Geoscience-Australia, Vice-Président de la CCGM pour l'Australie et l'Océanie.
   - Dr. Eikichi Tsukuda, Directeur Général du Service Géologique du Japon, AIST, Président de la Sous-commission des Cartes de Risques Naturels.
   - Dr. Marc Munschy, Professeur à l'Ecole et Observatoire de Physique du Globe IPGS/Strasbourg, France, Secrétaire Général de la Sous-commission pour les Cartes des Fonds Marins, et
4. **exprime** ses plus sincères remerciements au BRGM (Service géologique français) pour son soutien continu et généreux, et en particulier pour le renouvellement

support, and more particularly for renewing the nomination in 2003 and 2004 of a member of its staff to fulfil the duties of Secretary General of CGMW, and

5. **expresses** its gratitude to the University of Roma III, the Istituto Nazionale di Geofisica e Volcanologia – INVG – (Italy), ANDRA (French National Agency for Nuclear Waste) and the IPEV (French Polar Institute) for their scientific input and generous sponsoring for the preparation and publication of the CGMW maps published on the occasion of the 32 IGC, and

6. **warmly thanks** IUGS and EPISODES's Chief Editor for contributing to the promotion and visibility of CGMW publications, and

7. **gives** its warmest thanks to UNESCO for its support to the preparation and publication of CGMW maps, and

8. **thanks** IUGS for its annual subsidy and additional support for the special map release at the 32 IGC, and

9. **deeply regrets** the decease of Ms. Anne Faure-Muret, a prominent figure of the Moroccan geology and a loyal and long time outstanding collaborator of the Commission, and

CONTINENTAL SUBCOMMISSIONS

SUBCOMMISSION FOR EUROPE

10. **thanks** Prof. F. Wellmer for his 12 years of efficient contribution to CGMW effort during his Vice-Presidency for Europe, and

11. **welcomes** Dr. K. Asch as new CGMW Vice-President for Europe*,* and

12. **appreciates** the completion of the 1:4 000 000 Geological Map of Land and Sea Areas of Northern Europe by Dr. E. Sigmond of the Norwegian Geological Survey, and

13. **appreciates** the completion of the Map of the Metamorphic Structure of the Alps at the 1:1 000 000 under the coordination of Prof. R. Oberhänsli, University of Potsdam, Germany, and

14. **appreciates** the completion of the 1:5 000 000 International Geological Map of Europe and Adjacent Areas (IGME 5000) and the leadership of Dr. K. Asch, Federal Institute of Geoscience and Natural Resources (BGR) of Germany for coordinating the contribution of 48 countries, and

15. **acknowledges** the progress of the International Hydrogeological Map of Europe at 1:1.5 000 000 under the coordination of P. Winter of the Federal Institute of Geoscience and Natural Resources (BGR) of Germany of which 21 out of 28 map sheets are completed. The map sheets Athens, Bucharest and Budapest are in progress, and

16. **proposes** the compilation of a geological map of the Mediterranean Sea area to be prepared with the

de la mise à disposition en 2003 et 2004 d'un membre de son personnel pour assurer les fonctions de Secrétaire Général de CCGM, et

5. **remercie** avec gratitude l'Université de Roma III, l'Istituto Nazionale di Geofisica e Volcanologia (INVG, Italie), l'ANDRA (Agence Nationale pour la gestion des Déchets Radioactifs) et l'IPEV (Institut polaire français) pour leur soutien scientifique et leur généreuse contribution à la préparation et la publication des cartes de la CCGM éditées à l'occasion du 32ème CGI, et

6. **remercie** chaleureusement l'IUGS et le Rédacteur en Chef d'ÉPISODES pour leur contribution à la promotion et à la visibilité des publications de la CCGM, et

7. **adresse** ses plus vifs remerciements à l'UNESCO pour son appui à la préparation et à la publication des cartes de la CCGM, et

8. **remercie** l'IUGS pour sa subvention annuelle et son aide complémentaire à la distribution de cartes éditées à l'occasion du 32ème CGI, et

9. **déplore** profondément le décès du Professeur Anne Faure-Muret, figure marquante de la géologie marocaine et collaboratrice exceptionnelle et fidèle de la Commission depuis des décennies, et

SUBCOMMISSIONS CONTINENTALES

SOUS-COMMISSION POUR L'EUROPE

10. **remercie** le Prof. Dr. F. Wellmer de son efficace collaboration pendant les 12 années au cours desquels il a œuvré en tant que Vice-Président de la CCGM pour l'Europe, et

11. **souhaite** la bienvenue au Dr. K. Asch comme Vice-Présidente de la CCGM pour l'Europe, et

12. **apprécie** la réalisation de la *Carte géologique des régions océaniques et continentales de l'Europe du Nord à 1:4 000 000*, réalisée par le Dr. E. Sigmond du Service Géologique de Norvège (NGU), et

13. **apprécie** l'achèvement de la *Carte de la structure métamorphique des Alpes à 1:1 000 000* réalisée sous la coordination du Prof. R. Oberhänsli, Université de Potsdam, Allemagne, et

14. **apprécie** l'achèvement la *Carte géologique internationale de 1:5 000 000 de l'Europe et des Régions avoisinantes* (IGME 5000), résultat de la collaboration de 48 pays, sous la coordination générale du Dr. K. Asch, Institut Fédéral des Geosciences et des Ressources Naturelles d'Allemagne (BGR), et

15. **prend acte** de l'avancement de la *Carte hydrogéologique internationale de l'Europe à 1:1.5 000 000* coordonnée par l'Institut Fédéral des Geosciences et des Ressources Naturelles d'Allemagne (BGR), dont 21 feuilles sur 28 sont déjà réalisées et 3 cartes (Athènes, Bucarest et Budapest) sont en cours de réalisation, et

16. **propose** de réaliser la compilation d' une *Carte*

involvement of the IGME 5000 project and the relevant contributions from specialists of the Mediterranean area, and

17. **supports** the initiative of the Subcommission to create a digital version of the 1:5 000 000 International Geological Map of Europe and the Mediterranean Areas, and

SUBCOMMISSION FOR AFRICA

18. **thanks** Dr. C. Frick for his effective and fruitful involvement in the Commission's activity during the time he served as CGMW Vice-President for Africa, and

19. **thanks** Prof. J. Sougy, resigning Secretary General for Africa, for his long standing and pioneering contribution for the advancement of Western Africa geology and devoted action at the CGMW since 1960, and particularly in the realization of the *Tectonic Map of Africa at 1:5 000 000,* and

20. **requests** the COUNCIL FOR GEOSCIENCE (SOUTH AFRICA) to continue with the development of the legend for the 1:5 000 000 *Seismotectonic Map of Africa* with a view to submitting the draft legend and map outline to the CGMW for the next general assembly in 2006, and

21. **recommends** that the CGMW approach the relevant geological surveys including COUNCIL FOR GEOSCIENCE (SOUTH AFRICA), BGS and BRGM with a view to establish an implementation team to compile a 1:5 000 000 *Lithostratigrahic Map for Africa*, and

SUBCOMMISSION FOR SOUTH AMERICA

22. **expresses** its satisfaction with the success of the *Geological Map of South America at the 1:5 000 000* prepared under the coordination of Dr. C. Schobbenhaus and launched at the 31st IGC, and

23. **welcomes** the start of the *International Tectonic Map of South America at 1:5 000 000* under the coordination of Prof. U. Cordani and Prof. V. Ramos, and

SUBCOMMISSION FOR SOUTH AND EAST ASIA

24. **endorses** the detailed proposal for compiling the 1:5 000 000 *International Geological Map of Asia* submitted by Acad. Ren Jishun. Six regional working groups will be convened as follows:

    - Northern Eurasia
    - Middle East
    - China, Mongolia and Korea
    - Japan and South-East Asia
    - South Asia
    - Seafloor

25. **recommends** that the Middle-East, Northern Eurasia and Seafloor Maps CGMW Subcommissions, and the geological surveys of Asian countries be involved in

géologique de la région de la mer Méditerranée, à préparer avec la participation du projet IGME 5000 et les contributions appropriées des spécialistes de cette région, et

17. **soutient** l'initiative de la Sous-commission pour mettre au point une version numérique de la *Carte géologique internationale de l'Europe à 1/5 000 000 et des régions méditerranéennes*, et

SOUS-COMMISSION POUR L'AFRIQUE

18. **remercie** le Dr. C. Frick pour sa participation efficace et fructueuse à l'activité de la Commission pendant le temps où il a été de Vice-Président de la CCGM pour l'Afrique, et

19. **remercie** le Prof. J. Sougy, Secrétaire Général pour l'Afrique, qui renonce à sa fonction, pour sa longue contribution à l'avancement de la connaissance de la géologie de l'Afrique occidentale et de son action dévouée à la CCGM depuis 1960, en particulier dans le cadre de la réalisation de la *Carte tectonique de l'Afrique à 1:5 000 000*, et

20. **invite** le Council for Geoscience, Afrique du Sud, à poursuivre l'établissement de la légende de la *Carte sismotectonique de l'Afrique à 1:5 000 000* afin d'en soumettre l'ébauche de la légende et les grandes lignes de la carte à la CCGM lors de la prochaine Assemblée générale en 2006, et

21. **recommande** que la CCGM contacte le Council for Geoscience, le British Geological Survey (BGS) et le BRGM en vue de constituer une équipe pour réaliser la compilation d'une *Carte lithostratigraphique de l'Afrique à 1:5 000 000*, et

SOUS-COMMISSION AMERIQUE DU SUD

22. **exprime** sa satisfaction devant succès de la *Carte géologique de l'Amérique du Sud à 1:5 000 000* préparée sous la coordination de Dr. C. Schobbenhaus et présentée lors du 31ème Congrès Géologique International, et

23. **accueille** le lancement de la *Carte tectonique internationale de l'Amérique du Sud à 1:5 000 000* sous la coordination des Prof. U. Cordani (Brésil) et V. Ramos (Argentina), et

SOUS-COMMISSION POUR L'ASIE DU SUD ET DE L'EST

24. **approuve** la proposition de l'Acad. Ren Jishun de compiler une *Carte géologique internationale de l'Asie à 1:5 000 000*. Six groupes de travail régionaux seront répartis comme suit :
    - Nord de l'Eurasie
    - Moyen-Orient
    - Chine, Mongolie et Corée
    - Japon et Sud-est asiatique
    - Asie du sud
    - Océan.

25. **recommande** que les Sous-commissions de la CCGM : Moyen-Orient, Eurasie du Nord et Cartes des

this project, and

26. **decides** that the international working group of the project will be set up by the Subcommission under the aegis of President Prof. J.P. Cadet and Secretary General Dr. Ph. Rossi. The map compilation will be conducted by the Subcommission for South and East Asia, and

27. **recommends** that the north-western limits of the map should have limited overlap with the International Geological Map of Europe (IGME 5000), and

SUBCOMMISSION FOR THE MIDDLE EAST

28. **notes** the progress achieved in the elaboration of the second edition of the *Geological Map of the Middle East* by Dr. A. Haghipour, CGMW Vice-President for the Middle East, and **recommends** that the legend be examined by a review committee before initiating the compilation of the relevant data and **asks** that the realization of the map be carried out in coordination with the CGMW Sea-floor maps, Africa and Metamorphic Maps Subcommissions and **asks** that the Geological Surveys concerned by the map be formally contacted, and

29. **acknowledges** the realization of a structural and kinematics pedagogic map of the World and **suggests** that this mapping project be submitted to a review committee in order to assess its relevance prior to its endorsement by CGMW, and

SUBCOMMISSION FOR NORTHERN EURASIA

30. **thanks** Dr. Yu. E. Pogrebitsky for his contribution to the activities of the Commission during the time he served as CGMW Vice-President for Northern Eurasia, and

31. **notes** with satisfaction the development of international collaboration, involving Russia, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan, China, Mongolia and the Republic of Korea for the preparation of the *Atlas of geological maps of Central Asia and adjacent areas at 1:2 500 000*, and

32. **acknowledges** the new international project for an *Atlas of Circum-Arctic Geological Maps at 1:5 000 000*, and **asks** the Subcommission for Northern Eurasia to prepare as soon as possible a detailed and complete proposal of this Atlas to be proposed to the other potential partners and relevant international bodies (IASC, IPY, IGC Nordic Consortium, etc.), and

33. **asks** the Subcommission for Europe and Subcommission for Tectonic Maps to provide the Subcommission for Northern Eurasia with the relevant support for the compilation of this Atlas Maps, and

SUBCOMMISSION FOR AUSTRALIA-OCEANIA

34. **thanks** Dr. J.H.C. Bain for his contribution to the

Fonds Marins, et les Services Géologiques des pays d'Asie concernées, soient impliqués dans ce projet, et

26. **décide** que le groupe de travail international du projet sera établi par la présente Sous-commission, sous l'égide du Secrétaire Général Dr. Ph. Rossi et du Président Prof. J.P. Cadet. La compilation de carte sera réalisée sous la conduite de la Sous-commission de l'Asie du Sud et de l'Est, et

27. **recommande** que les limites nord-ouest de la carte n'aient qu'un recouvrement restreint avec la *Carte géologique internationale de l'Europe* (IGME 5000).

SOUS-COMMISSION MOYEN-ORIENT

28. **note** les progrès réalisés dans l'élaboration de la deuxième édition de la *Carte géologique du Moyen-Orient à 1 :5 000 000* par le Dr. A. Haghipour, Vice-Président de la CCGM pour le Moyen-Orient, et **recommande** que la légende soit examinée par un comité de lecture avant d'entamer la compilation des données et **demande** que la réalisation de la carte soit effectuée en coordination avec les cartes CCGM de l'Afrique et de la Sous-commission des Cartes métamorphiques, et **demande** que les Services géologiques concernés par cette carte soient contactés officiellement, et

29. **prend acte** de la réalisation d'une *Carte pédagogique structurale et cinématique du Monde* et **suggère** que ce projet soit soumis à un comité de lecture afin d'évaluer sa pertinence avant son approbation par la CCGM, et

SOUS-COMMISSION EURASIE DU NORD

30. **remercie** le Dr Yu. E. Pogrebitsky pour sa contribution aux activités de la Commission pendant la durée de son mandat en tant que Vice-Président de la CCGM pour l'Eurasie du Nord, et

31. **note avec satisfaction** le développement de la collaboration internationale entre la Russie, le Kazakstan, l'Ouzbékistan, le Kyrgyzstan, le Tajikistan, le Turkmenistan, la Chine, la Mongolie et la République de Corée en vue de la préparation d'un *Atlas des cartes géologiques de l'Asie centrale et secteurs adjacents à 1:2 500 000*, et

32. **prend acte** du nouveau projet international d'un *Atlas des cartes géologiques Circum-Arctique à 1:5 000 000*, et **demande** à la Sous-commission Eurasie du Nord de préparer dès que possible un projet détaillé et complet pour cet atlas à proposer aux autres associés potentiels et institutions internationales appropriées (IASC, IPY, et Consortium nordique de l'CGI, etc.) et,

33. **demande** à la Sous-commission Europe et à la Sous-commission Cartes Tectoniques de soutenir de manière appropriée la Sous-commission Eurasie du Nord dans la compilation des cartes de cet atlas, et

SOUS-COMMISSION AUSTRALIE-OCÉANIE

34. **remercie** le Dr J.H.C. Bain pour sa contribution à la

Commission during the time he served as Vice-President for Australia-Oceania, and

SUBCOMMISSION FOR ANTARCTICA

35. **thanks** Dr G. Grikurov, CGMW Vice-President for Antarctica Subcommission and Dr. G. Leitchenkov for their kind and efficient help in the completion of the Antarctica part in the *Structural Map of the Indian Ocean*, and

36. **notes** with satisfaction the progress achieved in the compilation of the *Tectonic Map of Antarctica* at 1:7 500 000 based on continuous records of new field evidence, analytical and cartographic data relevant to the understanding of the Antarctic geological history, and

37. **recognizes** VNIIOkeangeologia's budget constraints slowing the completion of the final draft and the need to facilitate the project by giving it a formal international standing, and

38. **recommends** that the compilation be furthered as a component of the *Tectonic Map of the Earth's Polar Regions* to be proposed by CGMW to ICSU, SCAR, IASC and the Nordic Consortium of the 33 IGC as a contribution to the International Polar Year activities (IPY). The *Tectonic Map of Antarctica*, as a part of the Tectonic map of the Earth's Polar Regions project, is further detailed in the "Other mapping projects" section, and

39. **expects** that the final draft of the Antarctic component of this map in digital print-ready format will be reported to CGMW General Assembly in 2006, and

THEMATIC SUBCOMMISSIONS

SUBCOMMISSION FOR TECTONIC MAPS

40. **thanks** Acad. Ren Jishun, President of the CGMW Subcommission for South and East Asia for his help in comparing and drawing up the principles of conformity between the legends of the *Tectonic Map of China and Adjacent Regions at 1:5 000 000* and the *International Tectonic Map of Asia at 1:7 500 000* and transferring maps (including their digital versions) and materials on geology and tectonics of China, necessary for the *International Tectonic Map of Asia* final compilation, and

41. **asks** Acad. Ren Jishun, Vice-President of the Subcommission for South and East Asia to finish in the nearest future the compilation of the digital version of the tectonic map draft of China according to the legend of the *International Tectonic Map of Asia* and to communicate it to the Subcommission for Tectonic maps, and

42. **thanks** the CGMW, its President Prof. J. P. Cadet and Secretary General Dr. Ph. Rossi for their active

Commission pendant la durée de son mandat de Vice-Président de la CCGM pour l'Australie-Océanie, et

SOUS-COMMISSION POUR L'ANTARCTIQUE

35. **remercie** le Dr G. Grikurov, Vice-Président de la CCGM pour l'Antarctique et le Dr. G. Leitchenkov pour leur aimable et efficace contribution concernant la partie Antarctique de la *Carte structurale de l'Océan Indien*, et

36. **note** avec satisfaction le progrès réalisé dans la compilation de la *Carte tectonique de l'Antarctique à 1:7 500 000*, basée sur de nouvelles données de terrain, analytiques et cartographiques nécessaires à la compréhension de l'histoire géologique de l'Antarctique, et

37. **prend note** des contraintes budgétaires de VNIIOkeangeologia qui ont ralenti la réalisation du projet définitif et de la nécessité de faciliter la réalisation du projet en lui conférant officiellement une importance internationale, et

38. **recommande** que sa compilation soit poursuivie comme composante de la *Carte tectonique des Régions Polaires de la Terre* à proposer par la CCGM à l'ICSU, au CPRA, à l'IASC et au Consortium Nordique du 33ème CGI en tant que contribution aux activités de l'Année Polaire Internationale (IPY). La *Carte tectonique de l'Antarctique*, comme partie du projet de la *Carte tectonique des Régions Polaires*, est en outre détaillée plus loin au chapitre "Autres projets cartographiques", et

39. **souhaite** que la maquette finale de la *Carte de l'Antarctique* faisant partie de ce l'ensemble précédent soit présentée à l'Assemblée Générale de la CCGM en 2006, sous un format numérique prêt à imprimer, et

SOUS-COMMISSIONS THÉMATIQUES

SOUS-COMMISSION DES CARTES TECTONIQUES

40. **remercie** l'Acad. Ren Jishun, Vice-président de la CCGM pour l'Asie du Sud et de l'Est, pour son aide dans l'élaboration des principes de conformité entre les légendes de la *Carte tectonique de la Chine et des régions limitrophes à 1:5 000 000* et celle de la *Carte tectonique internationale de l'Asie à 1:7 500 000*, et pour le transfert des cartes (y compris leurs versions numériques) et des données sur la géologie et la tectonique de la Chine, nécessaires pour la compilation finale de la *Carte tectonique internationale de l'Asie*, et

41. **demande** à l'Acad. Ren Jishun, Vice-président de la CCGM pour l'Asie du Sud et de l'Est, d'achever dans le futur le plus proche la version numérique de la *Carte tectonique de Chine* en suivant la légende adoptée pour la *Carte tectonique internationale de l'Asie* et de la communiquer à la Sous-commission pour les Cartes Tectoniques, et

42. **remercie** la CCGM, son Président Prof. J.P. Cadet et son Secrétaire Général Dr. Ph. Rossi pour leur participation active et leur aide à la compilation de la *Carte tectonique internationale de l'Asie*, et également

participation and help in the compilation of the *International Tectonic Map of Asia*, and also for providing cartographical data necessary to advance this work, and

43. **recommends** that the Subcommission for Tectonic maps and Subcommission for Northern Eurasia (Acad. Yu. Leonov, President of the CGMW Subcommission for Tectonic Maps and Dr. O. V. Petrov, CGMW Vice-President for Northern Eurasia) unite their efforts for the preparation of the digital version of the central part of the *International Tectonic Map of Asia* in order to achieve this compilation in 2006, and

44. **supports** within the framework of the IPY program the compilation, under the aegis of the CGMW, of two International tectonic maps with the participation of the Subcommission for Tectonic Maps: 1) the *International Tectonic Map of Antarctica* under leadership of the Subcommisson for Antarctica (CGMW Vice-President Dr. G.E.Grikurov) and 2) the *International Tectonic Map of Arctic* under the leadership of the Subcommission for Northern Eurasia (CGMW Vice-President Dr. O. V. Petrov and Secretary General S. P. Shokalsky), and

45. **recommends** that with the purposes of unifying continental and regional tectonic maps all Continental and Thematic Subcommissions undertaking the compilation of new tectonic maps coordinate their legends and guidelines with the Subcommission for Tectonic Maps, and place their final editing under the control of this Subcommission, and

46. **acknowledges** the preparation of the new edition of the *Tectonic Map of South America at 1:5 000 000*, and

47. **stresses** the need of rapidly implementing a close cooperation between the editorial boards of this map and the Tectonic Map of Africa currently under preparation in order to harmonize both legends, this point being all the more important since the fit of the older shields on each side of the Atlantic was at the base of the global tectonics concept, and

48. **appreciates** the innovative work carried out by Dr M. Pubellier (ENS, Paris) in the realization of the test-project *Geodynamic Terrane Map of Asia*, a new style of geodynamic map and **strongly recommends** to associate the South and East Asia, Northern Eurasia, Middle East, Seafloor maps and Australia-Oceania CGMW Subcommissions prior to submitting the draft map to an international review committee, and

49. **thanks** Council for Geoscience (South Africa) for the achievement of the southern part of equator of the *Tectonic Map of Africa* by G de Kock and **acknowledge**s the progress done in the digitization of the northern part of Equator since 2002, as well as of the 0-16°N sector synthesized by J. P. Milési (BRGM), the area North of 16°N compiled by J. Sougy and J. C. Guézou and the NE part and the Middle East part by J.C Guézou, and **encourages** the achievement and printing of this the *Tectonic Map of*

pour avoir fourni les données cartographiques nécessaires à l'avancement ce travail, et

43. **recommande** que la Sous-commission des Cartes Tectoniques (Acad. Yu. Leonov, Président de ladite Sous-commission) et la Sous-commission pour l'Eurasie du Nord (Dr. O.V. Petrov, Vice-Président de la CCGM pour l'Eurasie du Nord) unissent leurs efforts pour la préparation de la version numérique de la partie centrale de la *Carte tectonique internationale de l'Asie* afin d'en achever la compilation en 2006, et

44. **appuie,** dans le cadre du programme de l'IPY, la compilation sous l'égide de la CCGM de deux cartes tectoniques internationales avec la participation de la Sous-commission des Cartes Tectoniques : 1) la *Carte tectonique internationale de l'Antarctique* sous la conduite de la Sous-commisson pour l'Antarctique (Dr. G.E. Grikurov, Vice-Président de la CCGM pour l'Antarctique) et 2) la *Carte tectonique internationale de l'Arctique* sous la conduite de la Sous-commission de la CCGM pour l'Eurasie du Nord (Dr. O.V. Petrov, Vice-Président de la CCGM pour l'Eurasie du Nord et Dr. S.P. Shokalsky, Secrétaire Général de cette S/c), et

45. **recommande** qu'en vue de l'unification des cartes tectoniques continentales et régionales, toutes les Sous-commissions Continentales et Thématiques entreprenant la compilation de nouvelles cartes tectoniques coordonnent leurs légendes et leurs principes directeurs avec la Sous-commission des Cartes Tectoniques, et soumettent leur édition finale au contrôle de cette Sous-commission, et

46. **prend acte** de la préparation de la nouvelle édition de la *Carte tectonique de l'Amérique du Sud à 1:5 000 000*, et

47. **souligne** le besoin de mettre en application rapidement une collaboration étroite entre les équipes de rédaction de cette carte et de la *Carte tectonique de l'Afrique* actuellement en cours de préparation afin d'harmoniser les deux légendes, ce point étant très important puisque l'ajustement des boucliers anciens de part et d'autre de l'océan Atlantique a été à l'origine du concept de dérive continentale, et

48. **apprécie** le travail innovant mené à bien par le Dr. M. Pubellier (ENS, Paris) dans la réalisation du projet de la *Carte géodynamique des terranes de l'Asie*, qui constitue un nouveau modèle de carte géodynamique, et **recommande** vivement d'associer les Sous-commissions d'Asie du Sud et de l'Est, d'Eurasie du Nord, du Moyen-Orient, des Cartes des Fonds Marins et d'Australie-Océanie de la CCGM, avant d'en soumettre la maquette à un comité de lecture international, et

49. **remercie** le Council for Geoscience (Afrique du Sud) pour la réalisation de la partie de la *Carte tectonique de l'Afrique* située au sud de l'équateur, par G. de Kock et **reconnaît** le progrès fait dans la numérisation de la partie au nord de l'équateur depuis 2002, du secteur 0° à 16° N synthétisée par J.P. Milési (BRGM), du secteur situé au nord de 16° N compilé par J. Sougy et J.C. Guézou, et le la partie NE du Moyen-Orient par J.C Guézou, et **encourage**

Africa for the next General Assembly in Paris 2006, and

SUBCOMMISSION FOR METALLOGENIC MAPS

50. **expresses its satisfaction** with the good progress being made with the *World Metallogenic Map of Large and Superlarge Mineral Deposits* and **encourages** General Coordinator Acad. Pei Rongfu from the Chinese Academy of Geological Sciences to continue the compilation in 2005 of the *World Metallogenic Map of Large and Superlarge Mineal Deposits* and **urges** the coordinators to have the draft map thoroughly reviewed, and **asks** Acad. Pei Rongfu and Dr. S. Cherkasov to finalize the project on time for the next General Assembly in Paris 2006, and

51. **encourages** the Chinese Academy of Geological Sciences and particularly Acad. Pei Rongfu to study the global metallogenic belts and provinces for large and superlarge deposits and complete the database compiled by the relevant participating members, and

52. **commends** Dr. Eduardo Zappettini for the sterling work he and his South American team have carried out in compiling the final draft of the *International Metallogenic Map of South America at 1:5 000 000* and explanatory text in record time, and **encourages** the group to finalize the map for publication in 2006 (CD-ROM / paper), and

53. **notes** the draft compilation of the *Metallogenic Map of the Middle East* presented by the Subcommission for the Middle East and **advises** that Dr. A. Aghanabati should adapt the legend to CGMW standards for approval and ensure that the greatest possible cooperation and interaction with all the countries in the region is obtained, and

54. **encourages** Acad. Pei Rongfu to pursue the idea of compiling a *World Map of Mineral Resources of the Oceans at 1:25 000 000* and together with Dr. E. Zappettini prepare a feasibility study with particular reference to (i) previous or current similar research carried out and available data, (ii) the institutions and individuals prepared to participate in the project, (iii) financial support by the various participating institutions, (iv) the extent of resources to be mapped, and their geological context, and (v) a preliminary legend. The feasibility study should be finalised by the end of 2005 and the first results should be presented at the Paris 2006 General Assembly, and

55. **requests** Dr. E. Hammerbeck to write up his ideas on the future of the activities of the Subcommission for the CGMW Bulletin, and to introduce some of his ideas into the new projects, and

SUBCOMMISSION FOR METAMORPHIC MAPS

56. **acknowledges** the realization of the *Map of the Metamorphic Structure of the Alps* compiled during the last two years under the leadership of Prof. R.

l'achèvement et l'impression de la *Carte tectonique de l'Afrique* pour la prochaine Assemblée **G**énérale à Paris en 2006, et

SOUS-COMMISSION POUR LES CARTES MÉTALLOGÉNIQUES

50. **exprime** sa satisfaction quant au bon avancement de la Carte *métallogénique mondiale des dépôts géants et supergéants à 1/25 000 000* et **encourage** le Coordinateur Général, l'Acad. Pei Rongfu de l'Académie Chinoise des Sciences Géologiques, à continuer la compilation en 2005 de cette carte et **invite expressément** les coordonnateurs à soumettre la maquette à un comité de lecture *ad hoc*, et **demande** à l'Acad. Pei Rongfu et au Dr. S. Cherkasov de terminer le projet pour la prochaine Assemblée générale à Paris 2006, et

51. **encourage** l'Académie Chinoise des Sciences Géologiques et en particulier l'Acad. Pei Rongfu à étudier les ceintures et les provinces métallogéniques mondiales pour les dépôts géants et supergéants et à compléter la base de données compilée par les membres participant à ce projet, et

52. **félicite** le Dr. Eduardo Zappettini pour le travail remarquable qu'il a effectué avec son équipe sud-américaine en compilant la maquette définitive de la *Carte métallogénique internationale de l'Amérique du Sud à 1:5 000 000* et la notice explicative dans un temps record, et **encourage** ce groupe à finaliser la carte pour sa publication en 2006 (version papier et CD-ROM), et

53. **note** la préparation d'une ébauche de compilation de la Carte *métallogénique du Moyen-Orient* présentée par la Sous-commission pour le Moyen-Orient et **recommande** que le Dr. A. Aghanabati adapte la légende aux normes de la CCGM pour son approbation et s'assure que soient obtenues les plus larges coopération et interaction possibles avec l'ensemble des pays de la région, et

54. **encourage** l'Acad. Pei Rongfu à poursuivre son idée de compilation d'une *Carte du mondiale des ressources minérales des océans à 1:25 000 000* et de préparer avec le Dr. E. Zappettini une étude de faisabilité, l'accent étant mis plus particulièrement sur (i) les recherches similaires effectuées antérieurement et en cours, et les données disponibles, (ii) les organismes et les individus susceptibles de participer au projet, (iii) l'aide financière susceptible de provenir des diverses institutions, (iv) la nature et l'importance des gisements à cartographier et leur contexte géologique, et (v) une légende préliminaire. L'étude de faisabilité devrait être finalisée pour la fin 2005 et les premiers résultats présentés à l'Assemblée Générale de Paris 2006, et

55. **invite** le Dr. E. Hammerbeck à exposer dans le bulletin de la CCGM son point de vue sur le futur des activités de la Sous-commission, et à sélectionner certaines de ses idées pour les nouveaux projets, et

SOUS-COMMISSION POUR LES CARTES MÉTAMORPHIQUES

56. **prend acte** de la réalisation de la *Carte de la structure*

Oberhänsli and distributed in 32nd ICG at Florence for which an international group developed a new concept of representation of peak metamorphic condition for a well defined time slot allowing to visualize different PT paths and hope that future work includes compilation of an interactive ArcInfo based version, and

57. **encourages** future plans concerning the finalising of the metamorphic map of North America**,** and

58. **welcomes** the near future compilation for 2005-2008 of a *Metamorphic Map of the Eastern Mediterranean Realm* and **endorses** the idea of a realization on a long term of a map of the metamorphic structure of the Himalayas, and

SUBCOMMISSION FOR NATURAL HAZARDS MAPS

59. **thanks** Dr. H. Kato for his active leadership during the 8 years of his mandate as President of the CGMW Subcommission for Natural Hazards Maps, and

60. **acknowledges** Dr. E. Zappettini's presentation of the project *Natural Hazards Map of the Andes*, under the Multinational Andean Project, a region where geohazards are particularly high, and

61. **asks** Dr. E. Zappettini to get in contact with Dr. E. Tsukuda, new President of the CGMW Subcommission for Geological Hazards Maps, in order to benefit from the experience acquired during the preparation of the *Eastern Asia Geohazards Map at 1:7 000 000* published in 2002, and

SUBCOMMISSION FOR SEAFLOOR MAPS

62. **thanks** Dr. J.A. Chesher for his contribution to the activities of the Commission during the period he served as President of the CGMW Subcommission for Seafloor Maps, and

63. **thanks** Dr. J. Ségoufin for his 21 years of cooperation to the Commission as Secretary General of the Subcommission for Seafloor Maps and **underlines** his efficient contribution to the realisation and completion in due time of the *Structural Map of the Indian Ocean*, and

64. **thanks** Dr. Ph. Bouysse for its presentation of a new cartographic project entitled *Structural Map of the Caribbean* at the scale of 1:4 000 000, and

65. **acknowledges** his recommendations as refers the feasibility of this mapping project, and

66. **takes note** that he accepts to take in charge the general coordination of the project in close cooperation with the US Geological Survey and other relevant organisations and specialists, and

67. **approves** the undertaking of the *Structural Map of North Atlantic* by the institutions and laboratories concerned on both sides of the ocean and **invites** CGMW Executive Bureau in Paris to convene a

métamorphique des Alpes compilée pendant les deux dernières années sous la conduite du Prof. R. Oberhänsli et distribuée lors du 32ème CGI à Florence, pour laquelle une équipe internationale a développé un nouveau concept de représentation des conditions du pic métamorphique pour une période de temps bien définie permettant ainsi de visualiser les différents chemins PT et **espère** que les travaux futurs incluront la compilation d'une version interactive sous ArcInfo, et

57. **encourage** une future action concernant la finalisation la *Carte métamorphique de l'Amérique du Nord*, et

58. **prend acte** de la compilation dans un futur proche (2005-2008) d'une *Carte métamorphique du domaine de la Méditerranée orientale* et **approuve** l'idée d'une réalisation, à une échéance plus au moins longue, d'une *Carte de la structure métamorphique de l'Himalaya*, et

SOUS-COMMISSION DES CARTES DE RISQUES NATURELS

59. **remercie** le Dr. H. Kato pour les 8 années actives de son mandat de Président de la Sous-commission de la CCGM des Cartes de Risques Naturels,

60. **prend acte** de la proposition, par le Dr. E. Zappettini et dans le cadre du Projet Andin Multinational, d'une *Carte des risques naturels des Andes*, une région où les risques naturels sont particulièrement élevés, et

61. **demande** au Dr. E. Zappettini de prendre contact avec le Dr. E. Tsukuda, nouveau Président de la Sous-commission de CCGM des Cartes de Risques Naturels, afin de bénéficier de l'expérience acquise au cours de la préparation de la *Carte des risques naturels de l'Asie de l'Est à 1:7 000 000* publiée en 2002, et

SOUS-COMMISSION DES CARTES DES FONDS MARINS

62. **remercie** le Dr. J.A. Chesher pour sa contribution aux activités de la Commission au cours de son mandat à la Présidence de la Sous-commission de CCGM des Cartes des Fonds Marins, et

63. **remercie** le Dr J. Ségoufin pour ses 21 années passées à la Commission en tant que Secrétaire Général de la Sous-commission des Cartes des Fonds Marins et **souligne** son active contribution à la réalisation et à l'achèvement dans les délais impartis de la *Carte structurale de l'Océan Indien*, et

64. **remercie** le Dr Ph. Bouysse pour sa présentation d'un nouveau projet cartographique intitulé *Carte structurale de la Caraïbe à l'échelle de 1:4 000 000*, et

65. **prend acte** de ses recommandations à propos de la faisabilité de ce projet cartographique, et

66. **prend note** qu'il accepte d'assurer la coordination générale du projet en collaboration étroite avec le Service Géologique des USA et les autres organismes et spécialistes compétents, et

67. **approuve** le lancement de la *Carte structurale de l'Atlantique Nord* par les organismes et les laboratoires concernés des deux côtés de l'océan et

workshop in conjunction with the Subcommission for Seafloor Maps in order to rapidly launch this project, and

68. **approves** the undertaking of the *Structural Map of South-West Pacific* by the specialised institutions in Australia, New Zealand, New Caledonia and Hawaii, and **invites** CGMW Executive Bureau in Paris to convene a workshop in conjunction with the Subcommission for Seafloor Maps in order to rapidly launch this project, and

SUBCOMMISSION FOR HYDROGEOLOGICAL MAPS

69. **appreciates** that BGR, UNESCO, CGMW, IAEA and the International Association of Hydrogeologists (IAH) have joined efforts to build up a World-wide Hydrogeological Mapping and Assessment Project (WHYMAP) for groundwater related data, and

70. **congratulates** BGR and UNESCO for co-publishing the Special 32 IGC Edition of the *Groundwater Resources of the World at the scale of 1:50 000 000*, which is derived from WHYMAP, and

71. **invites** hydrogeological experts from Geological Surveys on all continents to provide additional input relevant to WHYMAP, via CGMW Vice-Presidents for Continental Subcommissions, and

72. **looks** forward to the publication of the global groundwater map at the scale of 1:25 000 000 in 2006, and

73. **welcomes** the continuous input of BGR and UNESCO for compilation and publication of the series of the International Hydrogeological Map of Europe (IHME 1500), and

74. **invites** the Geological Surveys particularly in South-Eastern Europe to continue their support for IHME and provide pertinent national contributions for the map sheets and explanatory notes under compilation in order to conclude the map series as soon as possible, and

75. **recommends** the preparation of a digital version of the IHME 1500 in order to produce a homogeneous set of hydrogeological data for Europe and adjacent areas to the East, to underpin the European Water Framework Directive with relevant groundwater related data, and

76. **recommends** to BGR, UNESCO and IAH to consider the preparation of a digital international hydrogeological map of Europe at the scale of 1:5 000 000, which should be compatible with the IGME 5000 now under completion, and

OTHERS MAPPING PROJECTS

GEOLOGICAL MAP OF THE WORLD AT SCALE 1:25 000 000

77. **acknowledges** the need of a 3rd edition of the *Geological Map of the World at 1:25 000 000*

invite le bureau exécutif de la CCGM à Paris à organiser une séance de travail en liaison avec la Sous-commission des Cartes des Fonds Marins, afin de lancer rapidement ce projet, et

68. **approuve** le lancement de la *Carte structurale du Sud-Ouest Pacifique* par les organismes spécialisés en Australie, en Nouvelle Zélande, en Nouvelle-Calédonie et à Hawaï, et **invite** le Bureau exécutif de CCGM à Paris à tenir une séance de travail en liaison avec la Sous-commission des Cartes des Fonds Marins afin de lancer rapidement ce projet, et

SOUS-COMMISSION DES CARTES HYDROGÉOLOGIQUES

69. **apprécie** que le BGR, l'UNESCO, la CCGM, l'AIEA et l'Association Internationale des Hydrogéologues (IAH) aient joint leurs efforts pour réaliser un projet hydrogéologique mondial (WHYMAP) concernant les données relatives aux eaux souterraines, et

70. **félicite** le BGR et l'UNESCO pour la co-édition de l'édition spéciale, à l'occasion du 32ème CGI, de la *Carte mondiale des ressources en eaux souterraines à l'échelle du 1:50 000 000*, dérivée de la carte WHYMAP, et

71. **invite** les experts hydrogéologues des Services Géologiques sur tous les continents à fournir des données complémentaires concernant WHYMAP, par l'intermédiaire des Vice-présidents des Sous-commissions continentales de la CCGM, et

72. **espère** la publication de la *Carte mondiale des ressources en eaux souterraines à l'échelle de 1:25 000 000* de 2006, et

73. **apprécie** le soutien constant du BGR et de l'UNESCO pour la compilation et la publication de la série de *Cartes Hydrogéologiques Internationales de l'Europe (IHME 1500)*, et

74. **invite** les Services Géologiques, en particulier ceux d' Europe du Sud-Est, à poursuivre leur soutien à l'IHME et à fournir des contributions nationales adéquates pour la compilation des cartes et des notes explicatives afin d'achever cette série de cartes aussitôt que possible, et

75. **recommande** la préparation d'une version numérique de la carte IHME 1500 afin de fournir un ensemble de données hydrogéologiques homogène pour l'Europe et les régions adjacentes orientales, afin de conforter avec des données adéquates la directive-cadre européenne de l'Eau, et

76. **recommande** au BGR, à l'UNESCO et à l'IAH d'envisager la préparation d'une *Carte hydrogéologique internationale numérique de l'Europe à l'échelle du 1:5 000 000*, compatible avec l'IGME 5000 actuellement en cours d'achèvement, et

AUTRES PROJETS CARTOGRAPHIQUES

CARTE GÉOLOGIQUE DU MONDE À L'ECHELLE DE 1:25 000 000

77. **prend acte** de la nécessité d'une 3ème édition de la

following the commercial and educational success of the 2nd edition published in 2000, and **asks** Dr. Ph. Bouysse to undertake the coordination of this new edition in order to update the previous digitized version and improve its educational aspects in particular as concerns the continental areas, and

78. **thanks** CGMW Vice-President for Europe and BGR for the proposal to support the realization of this map, and

ENVIRONMENTAL MAPS

79. **acknowledges** and **thanks** the suggestion of the representative of the Geological Survey of Uzbekistan to pursue further the compilation of International Geoenvironmental Maps and that it become a priority subject at the next General Assembly, and

GEOPHYSICAL MAPS

80. **acknowledges** Dr. H. Gupta's proposal to complete geological maps with geophysical data and **encourages** depicting geophysical data, particularly gravity data (anomaly contours), where possible, on geological and thematic maps, and

81. **acknowledges** Dr J. V. Korhonen's proposal from GTK, Finland to realize a *World Digital Magnetic Anomaly Map*, and

TECTONIC MAPS OF THE EARTH'S POLAR REGIONS

82. **recommends** that CGMW presents the entire project to ICSU, SCAR, IASC, and the Nordic Consortium of the 33 IGC to be taken into consideration in the schedule of the International Polar Year activities and that coordinators and review committees be appointed. The CGMW Subcommissions concerned are:

    -for Antarctica: the Antarctica and Seafloor map Subcommissions;

    -for the Arctic: the Northern Eurasia, North and Central America, Europe and Seafloor Maps Subcommissions, and

83. **recommends** to convene a meeting as soon as possible to prepare and launch this project in order to complete and publish a printed and digital versions for the 33 IGC in 2008, and

84. **encourages** VNIIOkeangeologia to speed up the preparation of the draft of the *Map of dynamic geology of the Arctic* to enable the soonest possible involvement in the compilation of this map of interested European and North American scientists and **expects** that the first draft of this map will be available for discussion at the next CGMW General Assembly in Paris in 2006, and

STANDARDS

85. **recognizes** the contribution made by the working

Carte géologique du Monde à 1:25 000 000 après le succès commercial et pédagogique de la 2ème édition publiée en 2000, et **demande** au Dr. Ph. Bouysse d'entreprendre la coordination de cette nouvelle édition afin de mettre à jour la version numérisée précédente et améliorer ses aspects pédagogiques, en particulier en ce qui concerne les régions continentales, et

78. **remercie** le Vice-Président de la CCGM pour l'Europe et le BGR pour leur proposition de soutenir la réalisation de cette carte, et

CARTES ENVIRONNEMENTALES

79. **prend acte** et **remercie** la suggestion du représentant du Service Géologique d'Ouzbékistan de poursuivre la compilation des Cartes internationales des géo-environnements et de considérer ce sujet comme prioritaire à la prochaine Assemblée Générale et,

CARTES GÉOPHYSIQUES

80. **prend acte** de la proposition du Dr. H. Gupta de compléter les cartes géologiques avec des données géophysiques et **encourage** la représentation des données géophysiques, en particulier des données gravimétriques (contours d'anomalies), et quand cela est possible, sur des cartes géologiques et thématiques, et

81. **prend acte** de la proposition du Dr J. V. Korhonen du Service Géologique de Finlande (GTK) de réaliser une *Carte mondiale numérique des anomalies magnétiques*, et

CARTES TECTONIQUES DES RÉGIONS POLAIRES

82. **recommande** que la CCGM présente le projet complet à l'ICSU, au CPRA, à l'IASC, et au Consortium Nordique du 33ème CGI pour qu'il soit pris en compte dans le calendrier des activités de l'Année Polaire Internationale (IPY) et que des coordonnateurs et membres du comité de lecture soient désignés. Les Sous-commissions de CCGM concernées sont :
    – pour l'Antarctique : les Sous-commissions Antarctique et Cartes des Fonds Marins;
    – pour l'Arctique : les Sous-commissions Eurasie du Nord, Amérique Nord et Centrale, Europe, et Cartes des Fonds Marins, et

83. **recommande** d'organiser dès que possible une réunion de préparation et de lancement de ce projet afin d'achever et de publier une carte en versions imprimée et numérique pour le 33ème CGI en 2008, et

84. **encourage** VNIIOkeangeologia à accélérer la préparation de la maquette de la *Carte de la géologique dynamique de l'Arctique* pour permettre la participation de scientifiques européens et nord-américains intéressés dans la compilation de cette carte et **souhaite** que la première ébauche de cette carte soit disponible pour discussion à la prochaine Assemblée Générale de la CCGM à Paris en 2006, et

STANDARDS

85. **prend acte** de la contribution fournie par le groupe de

group DIMAS towards international standards for small-scale digital geological maps and **endorses** their future aims, and

86. **suggests** that the CGMW adopts the DIMAS metadata system and implements it as soon as possible as the operational version is completed, and

87. **acknowledges** the integration of the Geoterm working group within the DIMAS working group and **thanks** their members for their constructive contributions.

travail DIMAS sur les normes internationales pour les cartes géologiques numériques à petite échelle et **approuve** ses futurs objectifs, et

86. **suggère** que la CCGM adopte le système de méta-données de DIMAS et l'utilise dès que la version opérationnelle sera disponible,

87. **prend acte** de l'intégration du groupe de travail de Geoterm dans le groupe de travail de DIMAS et **remercie** leurs membres pour leurs contributions constructives.

THESE RESOLUTIONS WERE ADOPTED AT THE LAST PLENARY SESSION OF THE GENERAL ASSEMBLY ON MONDAY AUGUST 23, 2004 AT THE 32ND IGC IN FLORENCE, ITALY. THE CGMW EXECUTIVE BUREAU THANKS ALL PARTICIPANTS TO THE GENERAL ASSEMBLY FOR THEIR PARTICIPATION AND CONTRIBUTIONS TO THE DISCUSSIONS.

Ces résolutions ont été adoptées à la dernière session plénière de l'Assemblée Générale le lundi 23 août 2004 au 32e CGI à Florence, Italie. Le bureau exécutif de CCGM remercie tous les participants à l'Assemblée Générale pour leur présence et leurs contributions aux discussions.

CHANGES ON CGMW BUREAU MEMBERS

Approved by CGMW Bureau Members and ratified by the General Assembly on 23 August 2004 in Florence, Italy (32 IGC)

Subcommission	Position	Outgoing	Nomination	
			Name	Organisation/Country
EUROPE	Vice-President	Prof. Dr. F.W. Wellmer,	Dr. K. E. Asch	BGR / Germany
AFRICA	Vice-President	Dr. C. Frick	Prof. A.B. Kampunzu	University of Botswana
	Secretary General	Dr. J. Sougy	Dr. J.P. Milési	BRGM / France
SOUTH & EAST ASIA	Vice-President	Vacant	Prof. Ren Jishun	Institute of Geology / China
	Secretary General	Prof. Ren Jishun	Dr. H. K. Gupta	Department of Ocean Development /India
	Deputy Secretary General		Dr. Peng Qiming	China Geological Survey
NORTHERN EURASIA	Vice-President	Dr. Yu. E. Pogrebitsky	Dr. O. V. Petrov	VSEGEI / Russian Academy of Sciences
	Secretary General		Dr. S. P. Shokal'sky	VSEGEI / Russian Academy of Scences
AUSTRALIA-OCEANIA	Vice-President	Dr. J. H.C. Bain	Dr. C. Pigram	Geoscience Australia
NATURAL HAZARDS MAPS	President	Dr. H. Kato	Dr. E. Tsukuda	Geological Survey of Japan, AIST
SEAFLOOR MAPS	President	Dr. J.A. Chesher	Vacant	
	Secretary General	Prof. J. Ségoufin	Dr. M. Munschy	Ecole et Observatoire de Physique du Globe – IPGS / Strasbourg, France

Bureau Members's résumés are included in Annex, page 71.

CGMW BUREAU Meeting

21 August 2004 - Florence, Italy

Present

Dr. K. Asch (Germany), Vice-President for Europe
Dr. P. Bouysse (France), past Secretary General
Prof. J.P. Cadet (France), CGMW President
Dr. C. Frick (Republic of South Africa), past Vice-President for Africa
Dr. H.K. Gupta (India), Secretary General of the S/C for South & East Asia
Dr. A. Haghipour (Iran), Vice-President for the Middle East
Dr. E.C. Hammerbeck (South Africa), President of the S/C for Metallogenic Maps
Dr. H. Kato (Japan), past President of the S/C for Natural Hazards Maps
Dr. I. Lambert (Australia), on behalf of Dr. Chris Pigram, Vice-President for Australia-Oceania
Dr. G. Leitchenkov (Russia), on behalf of Dr. G. Grikurov, Vice-President for Antarctica
Dr. P. Lyttle (USA), Vice-President for North & Central America
Dr. J.P. Milési (France), Secretary General of the S/C for Africa
Dr. R. Missotten (UNESCO), Earth Science Division
Prof. M. Munschy (France), Secretary General of the S/C for Seafloor Maps
Prof. R. Oberhänsli (Germany), President of the S/C for Metamorphic Maps
Dr. C. Oiti Berbert (Brazil)), Vice-President for South America
Dr. O. V. Petrov (Russia), Vice-President for Eurasia
Dr. I. Pospelov (Russia), Secretary General S/C for Tectonic Maps
Dr. M. Pubellier (ENS – France), invited
Dr. Peng Qiming (China), Deputy Secretary General of the S/C for South & East Asia
Prof. Jishun Ren (China), Vice-President for South & East Asia
Dr. P. Rossi, CGMW Secretary General
Dr. S. Shokal'sky (Russia), Secretary General S/C for Northern Eurasia
Prof. J. Sougy (France), past Secretary General of the S/C for Africa
Dr. W. Struckmeier (Germany), President of the S/C for Hydrogeological Maps
Dr. E. Tsukuda (Japan), President of the S/C for Natural Hazards Maps
Prof. Ing. F.W. Wellmer (Germany), past Vice-President for Europe
Dr. E. Zappettini (Argentina), Secretary General of the S/C for Metallogenic Maps

Excused

Dr. G. Grikurov
Dr. C. Schobbenhaus
Dr. C. Pigram
Dr. J.H.C. Bain

Absents

Prof. A.B. Kampunzu

CGMW Plenary Assembly / *Assemblée Plénière de la CCGM*
FLORENCE – 32nd IGC August 22 and 23 2004
List of participants

Country	Name	Organisation	e-mail
Argentina	Dr. Victor Ramos	Universidad de Buenos Aires – Departamento de Geología	geologia@gl.fcen.uba.ar
Argentina	Dr. Susana Segal	SEGEMAR	
Brazil	Dr. Carlos Oiti Berbert	Ministério da Ciência e Tecnologia CGMW Vice-President for South America	coiti@mct.gov.br
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CGMW Plenary Assembly / *Assemblée Plénière de la CCGM*
FLORENCE – 32nd IGC August 22 and 23 2004

List of maps displayed during sessions
(published or drafts)

Liste des cartes exposées pendant les séances
(publiées ou maquettes)

SOUTH AMERICA

ARGENTINA
Segemar (Geological Survey of Argentina) and CGMW

- *International Metallogenic Map of South America*
  1:5 M, partial draft, plotted on August 2000, to be published in 2006. Compiler: Dr. E. Zappetini

BRAZIL
CPRM (Geological Survey of Brazil) and CGMW

- *Metamorphic Map of South America*
  1:5 M, published in 2004 by CPRM and CCGM

MEXICO

Consejo de Recursos Minerales

- *Geological Map of the Mexican Republic*
  1:4 M, draft, to be published on 2006(?). Edited by Consejo de Recursos Minerales

MIDDLE EAST

ARABIA SAUDI
Saudi Geological Survey

- *New Geological map of the Arabian Shield*
  1:1,750,000, draft, published on 2004 by Saudi Geological Survey

EUROPE

CGMW SUBCOMMISSION FOR EUROPE

- *International Geological Map of Europe*
  1:5 M, proof, published by BGR and CGMW
  On sale Autumn 2005

BGR- GERMANY, UNESCO, CGMW, IAEA, IAH

- *Groundwater Resources Map of the World*
  1:5M, published in August 2004 by UNESCO and BGR
  On sale

FINLAND
GTK Geological Survey of Finland

- *Central Finland Granitoid Complex*
  1:4M, published on 2002 by GTK
  On sale

FINLAND, NORWAY, SWEDEN, RUSSIA
Geological Survey of Finland, Norway and Sweden, Ministry of Natural Resources of Russian Federation

- *Geological Map of the Fennoscandian Shield*
  1:2M, published on 2001, ISBN 951-690-812-8. On sale

- *Magnetic Anomaly Map of the Fennoscandian Shield*
  1:2M, published on 2002, ISBN 951-690-817-9. On sale

- *Bouguer Anomaly Map of the Fennoscandian Shield*
  1:2M, published on 2002, ISBN 951-690-818-7. On sale

EURASIA

ENS – CNRS - BRGM

- *Geodynamic- Terrane Map of Asia*
  1:10M, draft, published on 2005

CHINA
CAGS (Chinese Academy of Geological Services)

- *Geological Map of China*
  1:5M, draft, published by Ren Jishun

CHINA, RUSSIA
Institute of Mineral Resources, CAGS, China & Vernadski Museum, SAR, RUSSIA

- *World Metalogenic Map of large and super large deposits*
  Draft compiled by Academician Pei Rougfu and D.V Rundqvist

OCEANIA

NEW ZEALAND
Institute of Geological and Nuclear Sciences

- *Auckland Map 3*
  1:250.000, published in 2001. On sale

- *Geological Map of New Zealand*
  1:2 000 000, published in. On sale

- *The New Zealand Continent*
  1:10.000.000, published in 2003. On sale

SPECIAL MAPS

- *Geodynamic Terrane Map of Asia*
  1:10 000 000, draft, CGMW, ENS, BRGM and CNFG (M Pubellier – F.Ego)

- *Tectonic Map of Africa (Northern part and NE part)*
  1:5 000 000, draft. CGMW and CNRS

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Paris, UNESCO

February/*février 2006*

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COMMISSION FOR THE GEOLOGICAL MAP OF THE WORLD

77, rue Claude-Bernard - 75005 Paris - France
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YEAR 2006 CGMW GENERAL ASSEMBLY – Paris, France

FIRST CIRCULAR LETTER

July 2005

Dear Colleague,

As customary every four years, the plenary sessions of our General Assembly are going to be held in Paris at the premises of UNESCO, from **Thursday 9th February to Friday 10 February 2006**.

The **Bureau Members** meeting (restricted to the Members) is scheduled for **Wednesday 8th February 2006**. It will be held at the headquarters of CGMW (77, rue Claude-Bernard 75005 Paris).

I will appreciate that you let us know if you envisage attending our biennial meeting. Please give your answer in the questionnaire below and send it either by fax (+33 1 43 36 95 18) or e-mail (ccgm@club-internet.fr).

Thanking you in advance for your kind reply, I remain,

Yours sincerely,

Philippe Rossi
Secretary General

Questionnaire

1. Do you envisage participating to the 2006 General Assembly in Paris (UNESCO)?

   YES ☐ NO ☐

2. Do you intend to show some recent geological maps (post 2004)?

   YES ☐ NO ☐

3. If yes, please indicate approximate area required to display these maps : ....m²

   and/or number of sheets..

4. Your name Mr. ☐ Ms . ☐ Dr. ☐ Prof. ☐ ....

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ASSEMBLEE GENERALE DE LA CCGM – 2006 – PARIS, FRANCE

PREMIERE LETTRE CIRCULAIRE

Juillet 2005

Cher Collègue,

Comme l'accoutumée tous les quatre ans, les sessions plénières de l'Assemblée générale de la CCGM se tiendront à Paris, dans les locaux de l'UNESCO, du jeudi 9 février 2006 au vendredi 10 février 2006.
La réunion des Membres du Bureau (réservée aux seuls Membres) est prévue pour le 8 février 2006. Elle aura lieu dans le siège de la CCGM (77, rue Claude-Bernard 75005 Paris).
Je vous saurais gré de nous faire savoir si vous envisagez de participer à notre rencontre biennale. A cet effet, veuillez nous transmettre votre réponse dans le questionnaire ci-dessus par télécopie (+33 1 43 36 95 18) ou par e-mail (ccgm@club-internet.fr).

Vous remerciant par avance, je vous prie, cher Collègue, de croire à l'expression de mes sentiments distingués..

Philippe Rossi
Secrétaire Général

Questionnaire

6. Est-ce que vous envisagez de participer à l'Assemblée Générale de la CCGM en 2006?

   OUI ☐ NON ☐

7. Souhaitez-vous exposer des cartes géologiques récentes (post 2004)?

   OUI ☐ NON ☐

8. Si oui, indiquez quelle est la surface dont vous avez besoin pour présenter ces cartes :.............m²
   et/ou nombre de feuilles ....

9. Votre nom Mr ☐ Mme. ☐ ....
   Dr ☐ Prof. ☐

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CONTINENTAL SUBCOMMISSIONS

SOUS-COMMISSIONS CONTINENTALES

Reports

SUBCOMMISSION FOR ANTARCTICA

by the Vice-president for Antarctica, Dr. G.E. Grikurov

The new *Tectonic Map of the Antarctic (1:7.5 M)* continued to remain in the focus of the Subcommission's activity, but the preparation at VNIIOkeangeologia of its final draft intended for international approval and subsequent publication was significantly slowed by severe cuts of research budget and re-orientation of the institute's mandate predominantly toward federal applied needs. In September, 2003 the working draft of the map was demonstrated at IX International Symposium on Antarctic Earth Sciences where it was received with interest but not documented by any special recommendation.

Among new developments relevant to upgrading the existing draft were important results of isotope geochemistry studies of basement rocks from Prince Charles Mountains in East Antarctica. Both the specimens from earlier Soviet/Russian Antarctic expeditions and those collected during recent (2002/2003) Prince Charles Mountains Expedition of Germany and Australia were analyzed in Russian laboratories. Obtained SHRIMP data and Sm-Nd model ages positively confirmed the existence of early Archean (3.9–3.2 Ga) and late Archean to Paleoproterozoic (3.2–2.0 Ga) crustal assemblages affected by Pan-African overprint c. 500 Ma ago.

Significant contributions to the overall Antarctic project were also provided by several regional mapping initiatives, both national and bilateral.

On national basis, PMGRE and VNIIOkeangeologia jointly undertook to cartographically summarize the results of Russian marine geophysical surveys in the sector between Gunnerus Ridge and Kerguelen Plateau (30^{o} – 85^{o} E) and to present them as a set of 1:2.5 M products including depth to basement map, sedimentary thickness map, magnetic and gravity anomaly maps, map of seismic reflectivity of acoustic basement, tectonic map and some others. In 2003 most of these maps were demonstrated at IX ISAES, and all of them are currently being utilized as source data for an ongoing overview compilation.

The bilateral projects partly overlapped the same sector but mainly extended it to west and east:

- In 2004 VNIIOkeangeologia, PMGRE and AWI (Alfred Wegener Institute, Germany) completed compilation of "Geophysical Atlas of the Coats Land and the Dronning Maud Land Continental Margins (40^{o}W – 40^{o}E)" containing the results of marine seismic surveys (accompanied by onboard magnetic and gravity measurements) off the Antarctic coast facing the Southern Atlantic and the western Southern Indian Oceans. The Atlas includes representative seismic sections, structural maps of acoustic basement and break-up unconformity, a variety of isopach maps, potential field maps and a series of interpretive maps and sections at scales between 1:1M and 1:2.5 M. Part of the maps are placed on CD but others are still not available for digital distribution, and for that reason the entire Atlas so far remains a proprietary product for internal use by its compilers, including use for compilation of 1:7.5 M Tectonic Map.
- A complementary set of data in nearby region was acquired in the course of three-year collaboration between PMGRE, VNIIOkeangeologia and NPD (Norwegian Petroleum Directorate) with the purpose to define the position and tectonic nature of the continent-ocean transition from the Antarctic continent to the Southern Atlantic Ocean. Valuable information relevant to improved understanding of Gondwana breakup in this part of the world was obtained and presented on tectonic, depth to basement and sediment thickness maps at 1: 2.5 M – 1: 5 M

scales; all these maps are intended for publication at some later date but in the meantime absorbed in compilation of 1:7.5 M Tectonic Map.

- The Antarctic offshore in the sector from 40º to 160º E became the focus of joint project between VNIIOkeangeologia, PMGRE and Geoscience Australia titled "Research into geological evolution of Australian Southern and conjugate Antarctic margins on the basis of compilation of gravity and magnetic data in the Antarctic sector and other geophysical data". During 2003 respective grids 5x5 km were developed and prepared for legible plotting as 1:5 M to 1:10 M maps. The project envisages joint publication of the results in scientific literature, subject to further agreement between the Russian and Australian parties.

Antarctic S/C actively participated in compilation of the Antarctic sector of *Structural Map of the Indian Ocean (1: 10 M)*. The main objective was to convert structural and tectonic elements of this particular sector into pre-set legend adopted for the entire project. In the part of East Antarctica's coastal mainland encompassed by the map generalized geology of bedrock outcrops was presented against sub-ice topography background, whereas the structural features recognized in the adjacent offshore were matched with the neighboring sheets.

A new CGMW project initiated in connection with the forthcoming IPY (International Polar Year, 2007-2008) is titled *Tectonic Map of the Earth's Polar Regions*. The draft proposal has been jointly developed by three Subcommissions (for Tectonic Maps, Antarctica and Northern Eurasia) for promotion to IPY planning bodies. Given their approval, the aforementioned new *Tectonic Map of the Antarctic* will become a component of this bi-polar compilation.

Several overview Antarctic compilations, both completed and planned, are formally unrelated to CGMW and either supervised by other international bodies, or endorsed by different professional groups within Antarctic earth science community. Recently completed *Magnetic Anomaly Map of the Antarctic* (ADMAP project) and digital *Antarctic Bedrock Topography Map* (BEDMAP project) are currently being considered for continuation under IPY umbrella with the purpose to upgrade the existing grids and develop improved map products. Digital *Antarctic Gravity Map* project so far remains the subject of ongoing negotiations, whereas new IBCSO project *(International Bathymetric Chart of the Southern Ocean)* already had its kick-off meeting in late July, 2004 in conjunction with SCAR science conference in Bremen.

Systematic printing of standard geological maps at local to outcrop scale is still maintained by some Antarctic Treaty countries as part of their national programs but on the whole this activity is obviously on decline, since practically all readily accessible outcrops on the continent have been visited and mapped in the process of reconnaissance and/or regional surveys. The future bedrock cartography in Antarctica is likely to concentrate on regional thematic maps summarizing the key geological features of individual relatively exposed mountainous areas

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SUBCOMMISSION FOR SOUTH AMERICA

By the Vice-President for South America, Dr. Carlos Oiti Berbert
and the Secretary General, Dr. Carlos Schobbenhaus

Since 2002 the efforts of the Subcomission were concentrated on three vast Projects approved by CGMW for the South American continent: a) the *Metamorphic Map at 1:5 M;* b) *the Tectonic Map at 1:5 M;* and c) *the Geological and Mineral Resources Map of South America at 1:1 M scale and Related Data Basis.* A fourth Map – *the Metallogenic Map at 1:5 M* -is being conducted by Dr. Eduardo Zappettini, from the Geological Survey of Argentina, under the general coordination of the Subcomission for Metallogenic Map.

The *Metamorphic Map at 1:5 M,* under the coordination of Profs. Eberhard Wernick (Brazil) and Francisco Hervé (Chile), and the important collaboration of Mr. Valter A. Barradas, from CPRM – Geological Survey of Brazil, was finally concluded and published on a CD-ROM format which was presented at the CGMW meeting during the 32nd International Geological Congress, in Florence, Italy. The participation of almost all the Geological Surveys of the continent was essential for this realization. Its original file is available on *pdf* at CPRM by request (tbf@cprm.gov.br).

The *Tectonic Map at 1:5 M* is being coordinated by Profs. Umberto Cordani (Brazil) and Victor Ramos (Argentina) who presented a first draft of the legend during the Florence meeting in 2004. A comission for the Brazilian area is being established with the participation of geocientists from all over the country and call for contributions has been made to all South American Geological Surveys.

The *Geological Map at 1:1 M (GIS – South America 1:1M*) is a joint project of ASGMI (Iberoamerican Association of Geological and Mining Surveys) and CGMW, and is being conducted under the coordination of Dr. Carlos Schobbenhaus (Brazil). It comprises 92 map sheets 6ºx4º, and the first 46 sheets (total and partial) covering the Brazilian territory was recently concluded by CPRM . An Executive Comission for the rest of the continent is under constitution. It is hoped that a deep discussion on the matter comes to occur during the 12th South American Geological Congress to be held in Quito, Ecuador, in May 2005.

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*

SUBCOMMISSION FOR EUROPE

By the Vice-President for Europe, Dr. Kristine Asch

Overview

Summary reports are provided for: the GIS and map project of the 1 : 5 Million International Geological Map of Europe and Adjacent Areas (IGME 5000), the International Hydrogeological Map of Europe, scale 1 : 1,5 Million (IHME 1500) and the CGMW Working Groups for Digital Map Standards, DIMAS and GEOTERM.

IGME 5000: The 1:5 000 000 International Geological Map of Europe and Adjacent Areas

The IGME 5000 map was completed as a proof print for the IGC in Florence in 2004, where it was presented at Topical Symposium T - 12.02 “Building on tradition: the joint European enterprise of the 1:5 000 000 international geological map of Europe and adjacent areas”, chaired by Kristine Asch, and Friedrich-Willhelm Wellmer (both: Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover).
For almost 10 years now the GIS and mapping project "The 1:5 Million International Geological Map of Europe and Adjacent Areas (IGME 5000)" is being under construction. This map was due to be presented at the IGC 2004, and the session was an excellent opportunity crowning the many years of work and honouring the contributing surveys, universities and other organisations who's voluntary participation made it possible. The concept of the session was to explain the IGME 5000 project, its methods and practically show its usefulness in the context of the geology of Europe. The session thus started with contributions about the history, background, methods and procedures of the IGME 5000 and continued with presentations about the major tectonic units (Precambrian, Caledonides, Variscides, Urals, North Atlantic Ocean, Northwest Africa, Alps, and the Mediterranean Sea). T12.02 finished with presentations about future uses of this kind of GIS map and culminated in a conclusive key note from Prof. Jean Dercourt about the map’s scientific and public value.

In addition the IGC provided an helpful opportunity to discuss the IGME 5000 proof print with many of the contributing scientists, receive suggestions on necessary optimisations and accelerate the review phase by distributing the presented proof print.

At the moment progress continues with including the last reviews from the 48 participating Geological Surveys and numerous universities. Almost all participating countries and reviewers have submitted their reviews to-date. The final completion of the off-shore part of the IGME 5000, which aspires to meet the (sometimes conflicting) expectations of some of the scientific advisors, is proving to be a considerable challenge.

The map is planned to be finally printed in winter 2005/2006 in order to be presented at the CGMW General Assembly in February 2006 in Paris. The completion of the GIS-database will take some more time, but it is hoped that the harmonized version can be released on the internet by summer 2006.

State of Implementation of the International Hydrogeological Map of Europe, scale 1:1,5 million (IHME 1500)

Dr. Peter Winter, BGR

From the IHME 1500 project consisting of total 27 sheets, 22 map sheets and 18 explanatory notes are published and on sale.

Further 3 map sheets and 7 explanatory notes are in preparation. BGR via the temporary employment of a project coordinator enforced the effort to finalise that project by the end of 2006. The actual state of implementation can be described as followed:

<u>A6 Lisboa:</u> Countries involved: Portugal, Spain

The map sheet A6-Lisboa was printed in August 2001. As there was no progress made with the explanatory notes in the last two years, it was decided to make the draft versions of these notes available for free on demand.

<u>C6 Roma:</u> Countries involved: France, Italy

Regarding the not yet completed explanatory notes the same procedure as above will apply.

<u>D5 Budapest:</u> Countries involved: Austria, Bosnia and Herzegovina, Bulgaria, Czech Republic, Croatia, Hungary, Poland, Romania, Slovak Republic, Slovenia, Ukraine, Yugoslavia

The map sheet is in the state of the final geoscientific preparation in the Hungarian Geological Institute. The deadline for the preparation is set to the end of 2005. Preparation of the final cartographic layout in BGR will commence early 2006. The map will be published by the end of 2006. There was no final decision made yet by the sheet coordinator whether there are resources left for the compilation of an explanatory booklet. In case such a booklet will be prepared, the deadline for preparation will also be December 2005 and publishing will take place by December 2006.

<u>D6 Athenai:</u> Countries involved: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Macedonia, Yugoslavia.

The map sheet is in the state of the final geoscientific preparation in the Greek Geological Institute. The deadline for the preparation is set to the end of 2005. Preparation of the final cartographic layout in BGR will commence early 2006. There was no decision made yet by the sheet coordinator whether an explanatory booklet will be compiled. Also for the explanatory notes the deadline for preparation will be December 2005 and publishing will take place by December 2006.

<u>E5 Bucuresti:</u> Countries involved: Bulgaria, Moldavia, Romania, Turkey, Ukraine

The map sheet is in the state of the final geoscientific preparation in the Romanian Geological Institute. The deadline for the preparation is set to April 2006. Preparation of the final cartographic layout in BGR will commence May/June 2006. The finalisation of the explanatory notes is foreseen to take place in the same time frame.

<u>E6 Ankara:</u> Countries involved: Bulgaria, Greece, Turkey, Cyprus

The map sheet was already printed in 1976. As there was no progress made with the explanatory notes in the last two years, it was decided to make the draft versions of these notes available for free on demand.

<u>D1 Nordkapp / F5 Tbilisi:</u>

It was decided not to compile these two map sheets.

CGMW Working Groups on Digital Standards: DIMAS and GEOTERM
Dr. Kristine Asch, BGR

CGMW Working Group on Standards for Digital Geological Data - DIMAS

Members:

Kristine Asch (Chair), Federal Institute for Geosciences and Natural Resources, Germany
John Broome, Earth Science Sector, Canada
Ian Jackson, British Geological Survey, UK
Dominique Janjou, Bureau de recherches géologiques et minières, France
Manuel Pubellier, École Normale Supérieure, France
Robert Tomas, Czech Geological Survey, Czech Republic
Per Ryhaug, Norwegian Geological Survey, Norway
David Soller, United Stated Geological Survey, USA
Bruno Vrielynck, Université Pierre et Marie Curie, France
Koji Wakita, Geological Survey of Japan, Japan
Contacts: Manie Byrnard, Council for Geoscience, South Africa; Frank Brassil, Geoscience Australia, Australia.

This Group was instigated at the CGMW General Assembly in Paris 2002, with the aim "to investigate and implement common CGMW standards for digital geological data structures and to review future mechanisms for digital data dissemination" (resolution No. 65). The results of the Working Group's activities were presented to the CGMW General Assembly at the 32nd IGC in Florence in 2004. Since the last report the Group has met twice, in Berlin to prepare the IGC (May 2004) and in association with the EGU conference in Vienna in April 2005. A next ("opportunistical") meeting will take place during the annual IAMG conference in Toronto in August 2005. Through these meetings and frequent e-mail contact, the Group is making good progress on creating templates ("profiles") to establish the standard components of 1 : 5 million scale maps and on a metadata system for all CGMW maps. A DIMAS website has been setup and is available at: www.geology.cz/host/dimas.htm.

GEOTERM: CGMW Working Group on Geological Terms and Term Dictionaries (sedimentary, metamorphic and igneous rocks) – GEOTERM

Members: Roland Oberhänsli, University of Potsdam; John Powell, British Geological Survey; Kristine Asch, Federal Institute for Geosciences and Natural Resources; Philippe Rossi, BRGM and CGMW

This Working Group was also initiated at the General Assembly of CGMW in Paris in 2002. Its task is to establish internationally standardised geological terms for igneous, metamorphic and sedimentary rocks for application to CGMW maps (Resolution, No. 64). The Group met only once, conducted its work mainly via e-mail and achieved the following results:
1) advice given on standard rock terms for metamorphic, plutonic, volcanic and sedimentary rocks for the IGME 5000
2) advice given on the agreed hierarchical rock classification for the IGME 5000, appropriate to the level of detail ….
3) and suitable for accompanying database schemes.

As GEOTERM was established to advise the IGME 5000 project until its finalisation and then disband it recommends to be left dormant until needed again and perhaps to be integrated with DIMAS at a later stage.

SUBCOMMISSION FOR THE MIDDLE EAST

By CGMW Vice-President, Dr. A. Haghipour

The activities of the CGMW-Subcommission for the Middle East since last General Assembly during the period 2002-2004 are hereafter summarized.

Structural and Plate Kinematics Map of the World

In accordance with CGMW resolution N° 66 (2002), a draft based on the *Seismotectonic Map of the World* was presented at the General Assembly in Florence. This redraft at the scale of 1:50 000 00 emphazises the plate kinematics and includes a number of updatings. Before obtaining approval for its publication, this *Structural and Plate Kinamatics Map* will go through the standard scientific review process.

International Geological Map of the Middle East

The preparation of the new edition of the *International Geological Map of the Middle East* (second edition, 1:5 M scale), is in the stage of compilation and takes into account the accessible recent data on continental, offshore and oceanic regions.

The preparation of the digitized geographical base map at the projection and scale established for CGMW regional maps, together with the general geological were completed. These data will submitted to the CGMW Subcommission for South and East Asia during the first workshop of the *International Geological Map of Asia – IGMA 5000* in Beijing (March 29 to April 3, 2005.

International Metallogenic Map of the Middle East

As it was reported, the CGMW Subcommission for the Middle East has the Geological and Mineral Survey of Iran's support for the preparation of the *Metallogenic Map of the Middle East* (first edition, 1:5 M scale). The compilation of the map, under Dr. A. Aghanabati's responsibility, is nearing completion. A pre-draft of the map, plotted on the recent geographic base of the Middle East, is already completed.

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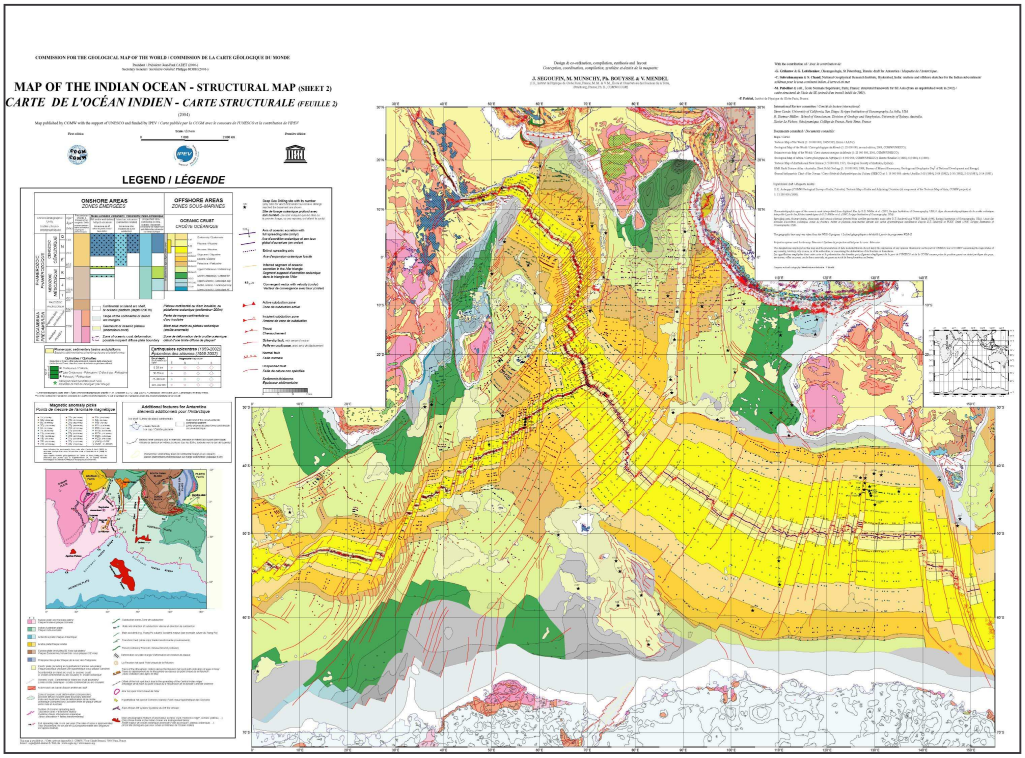
INTRODUCTORY NOTES OF
CGMW MAPS PUBLISHED IN 2004

THE MAP OF THE INDIAN OCEAN
Physiographic and Structural mapping of an ocean



ABSTRACT – *The two sheets of the* Map of the Indian Ocean *synthetize geological and geophysical data obtained from a great number of sea-going cruises carried out since several decades, allowing to get a synthetic overview of the history and structure of this ocean.*
On the ***Physiographic Map*** (Sheet 1), *the bathymetry, the picture of the seafloor and continental relief, the recent or currently active volcanoes, and the meteoritic impact craters* are mapped.
On the ***Structural Map*** (Sheet 2), *besides a simplified cartography of the onshore geological background, are represented:*

- *The age of the oceanic crust inferred from the identification of the inversion anomalies of the Earth's magnetic field.*
- *The plotting of the magnetic anomalies corresponding to the location where they have been measured.*
- *The spreading axes, transform faults and fracture zones, anomalous reliefs, and subduction zones that shape the morphology of the seafloor.*
- *The onshore and offshore earthquakes.*
- *The deep-sea drilling sites which reached the basaltic basement, with their identification number.*
- *Lastly, the contours of the sedimentary thickness where the density of the data allows it.*

FOREWORD

During the 1980's, the CGMW co-published with the UNESCO, and for the first time, the maps of the five oceans of the globe (including the "Antarctic ocean"), as part of the *Geological Atlas of the World* issued at a relatively small scale. Two decades have elapsed and our knowledge of the seafloor of the world improved in a very significant way; consequently, the Commission decided, six years ago, to initiate a new type of seafloor mapping program of a whole ocean.
The *Map of the Indian Ocean*[1], released for the 32nd IGC of Florence, is the first one of this series. The realization of the map, received some financial support from UNESCO and the Institut Paul-Émile Victor (IPEV, the French Polar Research Institute).

[1] Authors of the Map: Jacques Ségoufin, Marc Munschy, Philippe Bouysse, and Véronique Mendel, with the collaboration of Garrik Grikurov & German Leitchenkov (Russia), Challa Subrahmanyam & Shyam. Chand (India), Manuel Pubellier (France), and Philippe Patriat (France).

HOW TO MAP AN OCEAN?

Working out the map (and not the atlas) of an ocean while attempting to provide the most convenient synthesis of its main characteristics in the field of the Earth sciences, is not as obvious an exercise as one could think, if compared with the onshore cartography. Hereafter the reasons:

- The map cannot be a true geological one, describing the nature of the out- or sub-cropping formations as for the emerged areas; otherwise it would mainly represent Plio-Quaternary sediments.
- Neither is it possible to consider a tectonic map because of the specific evolution of the oceanic lithosphere and whose age is never older than some 200 Ma.
- The map is not the simple cartography of one single geophysical parameter (seismicity, gravimetric anomalies, heat-flow,…).
- It has also to include some geological data relevant to the onshore areas (islands and surrounding continents), unlike the majority of maps devoted to an oceanic area. As a matter of fact, such information sheds some complementary light to the understanding of the evolution of an oceanic basin, as e.g. the fit of the Precambrian shields on either side of the basin, before the splitting and drift of the continental fragments.
- It cannot be a simple stacking-up of different types of data, as it would impede an acceptable balance between readability and level of information.

For all these reasons, we did choose to coin this kind of cartography a «***Structural map***», a term not heavily constrained semantically.

As to the size of the paper print, our publisher experience led us to avoid too large dimensions (generating a number of sub-sheets) owing to different reasons: printing constraints, handling problems, availability of space for storage and display, reasonable selling price. Therefore, the final scale (1:20 000 000 at Equator) is twice as small as the one initially planned. The projection used here is the Mercator system, generally adapted by the offshore sciences community as e.g. the International Hydrographic Organization or the Intergovernmental Oceanographic Commission. Consequently, the southern boundary of the map was limited at 71° S, in order to avoid too large deformations of the mapped areas towards the South Pole while showing a significant surface of the Antarctic coastal fringe. Because of legibility constraints, the *Map of the Indian Ocean* is composed of 2 sheets at the same scale: Sheet 1- *Physiography,* as a kind of introductive map to the main one, Sheet 2- *Structural Map.*

PHYSIOGRAPHIC SHEET

It would have been very uneasy to add even few more meaningful information on the sole structural sheet. On the other hand, international geophysical data bases allow to produce very «fine-grained» computer-generated «physiographic» images of the surface of the Earth, with color-shaded relief based on land and seafloor elevation models, of great informational and aesthetic value. These two considerations determined the decision to produce a companion-sheet to the «structural» one: the *Physiography sheet*.

On the physiographic background, following 4 kinds of data (necessitating the minimal consumption of space in order to preserve, as well as possible, the quality of the relief image) have been added:

1) Selected **isobaths** drawn with a very fine line with -200, -1000 m contours, and then every 1000 m.
2) The totality of the active or Holocene[2] (< 10,000 yrs**)** **volcanoes**, all onshore, marked by a small red triangle. They represent some 300 eruptive centers, extracted from the Smithsonian online files (Washington D.C.). They are particularly concentrated along the Sunda arc (Indonesia), and in Ethiopia where they are mainly located along the Great East African Rift. If we bring together Sheets 1 and 2, we can note, for the latter region, coincidence between the distribution of the volcanoes and the line drawn by the earthquakes epicentres. On the other hand, no volcano is linked to the extensive seismicity generated by the continental collision located to the North of India, in the Himalayas. Inside the Indian Ocean, the only volcanoes known to have had *historic eruptions*[3] are: the Karthala (Grande Comore); the McDonald and Heard volcanoes located to the SSE of the Kerguelen archipelago. The volcano of St Paul island (in the St Paul-Amsterdam group) on the Southeast Indian Ridge; and of course the Piton de la Fournaise of Réunion, one of the most active volcano of the world.
3) Some 40 **astroblemes** (or meteoritic impact craters), the majority of which being located on the Australian craton; they are marked by a small green inverted triangle; they have been selected from the Planetary & Space Science Center database of the New Brunswick University.
4) **Toponymy**, with a selection of towns, rivers and islands, and of the main submarine morphostructures, the latter named in accordance with the International Hydrographic Organization recommendations.

STRUCTURAL SHEET

ONSHORE AREAS

The Indian Ocean is the result of the break-up of the Gondwana supercontinent from Early Jurassic onwards (ca.200 Ma), and involves the drift apart of continental fragments of various size: Africa, India, the Seychelles[4] microcontinent, Madagascar, Australia, Antarctica, Arabia, (and also South America, but whose drift is related to the opening of the South Atlantic). The origin and geological nature of the Agulhas Plateau (near the southern tip of Africa) is still debated: a submerged continental micropiece, according to some researchers (cf. e .g. the Exxon/GSA Tectonic Map of the World, 1985/1995), or a relief with a basement of anomalous oceanic crust?

The onshore continental areas are very schematically represented by:

- Archean and Proterozoic (or undifferentiated Precambrian**)** **cratonic areas** .
- **Phanerozoic** (i.e. Paleozoic to Present) **basins or platforms** .
- **Phanerozoic orogenic belts**: **Paleozoic**, (e.g. South African tip), **Mesozoic** (e.g. Malaysian peninsula), **Cenozoic** (e.g. the Himalayas resulting from the collision of India with Eurasia, initiated at about 50 Ma) belts, considering only the last main orogenic phase when multiple orogenies occurred.
- The **Meso-Cenozoic volcanism** which accompanies the different steps of the evolution of the Indian Ocean, is

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[2] The beginning of the Holocene has been recently (2004), and officially (by the International Commission on Stratigraphy), moved back to 11,500 years B.P

[3] The notion of historic activity (i.e. recorded in written documents more or less contemporaneous with the eruptions) is quite flexible. For the Indian Ocean area, it is rarely older than the XVIIth century.

[4] Small continental block composed of Late Proterozoic granites and separated from India during Late Cretaceous. The largest island of this tiny granitic archipelago is Mahé (144 km^2) sheltering the capital, Victoria. The other Seychelles archipelagos, called "Outer Islands" (Almirantes, Farquar, Cosmoledo, Aldabra,…) are made of coral limestones and were built up on an oceanic crust basement.

subdivided into horizontal chronologic units, and into 3 main geodynamic vertical categories:

- *Rift and/or well-defined hot spot volcanism*: the Indian traps of Deccan which poured out at the end of the Cretaceous (ca. 65 Ma), corresponds to the initial powerful head of a hot spot plume that operates nowadays, with a reduced rate (hot spot tail) beneath Réunion. The Rajmahal and Sylhet traps, located respectively to the NNW and NNE of the Ganges-Brahmaputra delta, indicate the activity of a hotspot activity during Early Cretaceous (ca. 120 Ma). As regards the Neogene volcanism of the Great East African Rift and of Arabia, it is still premature, due to the scale of the map and to the state of the regional surveys, to discriminate graphically between the Ethiopian and Yemen hot spot traps (ca. 30 Ma, by the end of Paleogene) and the subsequent volcanism connected to the rifting of Great East African valley system and to the opening of the Gulf of Aden and of the Red Sea ("Harrats" of Saudi Arabia).
- *Cenozoic subduction-related volcanism* (*cf. infra* "Subduction zones") exemplified by the Cenozoic Sunda volcanic arc and its hundred or so active or recent volcanoes rooted on the rim of the Eurasia megaplate which overthrust the subducted oceanic crust (of Upper Jurassic to Eocene age) of the India-Australia plate.
- *Unspecified volcanism*, such as the Quaternary volcanoes of SE Australia (Victoria State), until now, unrelated to a clear geodynamic process.

- **Ophiolites**, the result of a Late Cretaceous obduction in Oman, or of the catch of ocean lithosphere within suture zones, are mapped in collision belts (e.g. in the Zagros mountains, Iran). An indication of the age of the oceanic crust is given, when known.
- The **tectonic features** are indicated by faults (normal, strike-slip as e.g. the Semangko fault in Sumatra, and unspecified), and first order thrust like the Himalaya Frontal Thrust.

ANTARCTIC AREA

Antarctica necessitated a specific treatment due to the occurrence of the huge inlandsis. Only scattered outcrops in the coastal areas have been «conventionally» mapped (mainly Precambrian formations). Beneath the ice-cap, the relief of the rocky substratum is suggested with a 500m-spaced isobath contouring, showing that substantial parts of the overloaded continent are depressed below the sealevel, particularly the Amery graben (ca.70°-75°E) and to the East. Likewise, the edge of the continental shelf is not defined, here, by the traditional 200m isobath (see "Offshore areas"), and located at a deeper level; hence the Legend wording: «outer limit of the circum-antarctic platform». The true coastline and the edge of the ice-shelf[5] (i.e. the seaward extension of the ice-cap) are marked by two different kinds of lines.

OFFSHORE AREAS[6]

MAGNETIC ANOMALIES AND AGE OF THE OCEANIC CRUST

When the lavas are cooling, they fossilize the direction and intensity of the Earth's magnetic field, allowing, hence, the dating of the basaltic crust accreted to the seafloor.
Consequently, a time scale of the geomagnetic reversals has been established which allowed to identify a number of characteristic magnetic anomalies and to give them an age. Hence, it was possible, from the location and identification of these magnetic anomalies, to get the age of the oceanic crust and to evidence the *seafloor spreading* process.

The first pertinent element to consider in the "geological" mapping of an ocean is the age of the oceanic crust forming the basement of the seafloor. Here, we give the *chronostratigraphic ages* (epochs, with conventional geological colors) and not the geomagnetic ages (or "*chrons*" corresponding to the chronology of the magnetic anomalies*)* as usually displayed by the geophysicists, in order to be consistent with geological events (e.g. the K/T boundary. These chronostratigraphic (geological) ages of the oceanic crust have been obtained by interpolation computed from digitized files of the magnetic anomalies by Müller *et al*., 1997 (Scripps Institution of Oceanography). But it was considered of value to show also the exact location of the magnetic anomaly picks. In the legend, a table provides the list of each standard anomaly (or *chron*) and its age, following the geomagnetic time scale after Cande & Kent (1995) from chron 1o (0.78 Ma) to chron 33o (79.075 Ma), and after Gradstein *et al.* (1994) for chron 34y (83.0 Ma) and older. These picks are represented by a tiny open circle filled with a specific color for each chron.

Following structural features of the oceanic crust have been mapped: *axes of oceanic accretion* with full current spreading rates in cm/yr, and occasionaly *extinct spreading axes* (as in the Somali basin) are shown*; transform faults* and their extensions, the *fractures zones*.

ANOMALOUS SUBMARINE RELIEFS

Reliefs corresponding to anomalous volcanic basement (seamounts, «aseismic» ridges, oceanic plateaus, or features of uncertain or disputed origin like the Kerguelen Plateau - hotspot induced or continental crust? -) are represented by a pale yellowish green color. As to the Agulhas Plateau, its nature is still debated, (see above), and we have discarded, here, a clear continental origin. The Ninety East Ridge is a remarkable rectilinear morphotectonic feature linked to the northward drift of India.

SUBDUCTION ZONES

A large subduction zone (more than 6 000 km) runs along the southern rim of the *Sunda island arc* (Indonesia). As a matter of fact, the underthrust oceanic crust of the Indian Ocean, relatively cold, is progressively heated when forwarding into the plastic asthenospheric mantle wedge, and experiences dehydration which triggers partial melting of the overlying mantle, source of the magma that will build up the island arc volcanoes. This active subduction zone is marked by a red line with solid triangles of the same color. Subduction vectors show the orientation of the convergence (rate in cm/yr) with respect to the curvature of the arc. With a subduction toward the NNE, the convergence is relatively frontal before Western Java, and quite oblique toward the North-Western tip of Sumatra; this geometry induces the large strike-slip (dextral) movement of the Semangko fault that cuts through the whole length of the latter island. North of Sumatra, this same subduction pattern generates a distensive stress which induces the opening of the small Neogene Andaman marginal basin. This currently active back-arc basin is featured with its oceanic crust, its small accretionary axes and their transform faults. Farther to the North, in Burma, the same general stress is transformed into a large wrench faulting system.

A southward incipient subduction zone where the oceanic crust of the Banda marginal basin plunges beneath the northern coasts of the Lesser Sunda archipelago (East of 120° E), is to be noted; it is indicated by a red line with open triangles. This recent subduction accommodates the initial stage of the collision of Australia with the Sunda arc. This collision caused the uplift that produced the emergence of Timor, Sumba and neighbouring islands, pinched between the two blocks.

Another subduction zone of much smaller size (some 900 km long), is located in front of the shores of Baluchistan (straddling

[5] Not to be confused with the "sea ice" which is frozen seawater of few meters (or decimetres) thickness.

[6] Conventionally, the Indian Ocean is bounded by the meridians passing through *Agulhas Cape* to the West, and through *South East Cape* (Tasmania), to the East.

Pakistan and Iran): the *Makran subduction.* The subducted Cretaceous oceanic crust, - belonging here to the Arabia plate (bounded to the East by the Owen transform fault) – dips toward the NNE beneath the Iran block (incorporated to the Eurasian megaplate). The subduction generates an accretionary sedimentary prism with a thickness of several kilometres, most of it being located onshore. Farther backwards, the related, small volcanic arc comprises some Holocene volcanoes (among which the Taftan).

DEEP-SEA DRILLINGS

Among the international deep-sea drilling sites carried out by international scientific consortiums (DSDP, IPOD, ODP, IODP), are only plotted (black stars with their identification number) those having reached the basaltic basement. These drillholes are very important, because the cores sampled at the base allow to date the basalt samples using radiometric methods, or to give the age of the sediments overlying directly the basalt, thanks to their microfauna. In the latter case, the age of the oceanic crust predates the sediment. These drillings allowed to check the age of the oceanic crust provided by the magnetic anomalies, and to validate the seafloor spreading hypothesis

SEDIMENT THICKNESS

Indications concerning the thickness of the sediments overlying the ocanic basement are rather scarce. Areas with enough data permitting to draw isopachs (curves of equal thickness) concerns mainly the continental margins and rises of India, East Africa, and Antarctica. The thickness is indicated by the overprint of a greyish shading whose intensity increases from 0 to 15 km. It is not surprising to see that the maximum thickness (14 km!) is located in front of the Ganges-Brahmaputra delta because of the huge sedimentary input coming from the Himalayas. Before the Indus delta, it is much weaker (4 km). Downslope of the continental margin of southern Somalia-Kenya-Tanzania, the sedimentary wedge reaches up to 9 km; unlike the former example, this significant thickness is not related to any large and powerful known fluvial system.

ZONE OF OCEANIC CRUST DEFORMATION

Between India and Australia, but closer to the former, appears a region of deformation (compressional stresss) of the oceanic crust joining part of the Central Indian (accretionary) Ridge to the Sumatra subduction trench. This area, overprinted with horizontal hatching, is also characterized by diffuse seismicity ; it might correspond to a zone of future definite rupture within the India-Australia plate, initiating the creation of two separate plates.

AFAR TRIANGLE

The Afar triangle and the southern end of the Red Sea is a region of particular interest, linking the rest of that narrow sea, of recent oceanization (Plio-Quaternary) to Gulf of Aden, which opened a little bit earlier (Miocene), and to the Great Rift Valley. In the Afar triangle, the onshore volcanics correspond actually to oceanic crust with active accretion. Nevertheless, they are treated cartographically as onshore volcanism, since the oceanic crust underwent, in this area, uplift and partial emersion due to a hot spot bulge, the action of which began to start by the end of Oligocene (*cf. supra,* the Ethiopian traps). However, the inferred location of the axes of current accretion is indicated by a green dotted line.

CONTINENTAL MARGINS

The continental margin represents the part of the continent situated beneath the sealevel. It includes both the continental shelf – more or less arbitrarily bounded by the 200 m isobath – and the continental slope that meets, at about -3000 m, the seafloor underlain by the oceanic crust. The shelf is shown in white and the slope in a light blue. Because the island arcs are built up of continentalized crust, their submarine parts recieve the same cartographic treatment.

THE MOST PROMINENT MORPHOSTRUCTURES ON THE MAP. THE THREE SPREADING RIDGES

The Indian Ocean originated progressively from the break-up of the Gondwana supercontinent and the complex drifting of the different split continental blocks which, under the action of the spreading axes of the accretionary ridges (locus of injection of the magma that will form the oceanic crust) move away from each other.

The Indian Ocean is characterized by the existence of three large accretionary ridges whose spreading rates, corresponding to the quantity of magma supplied at their axis during a same period of time, are very different. These ridges share a common point, the Rodrigues triple junction, located at 70° E and 26° S, close to the eponymous island. They form the boundaries between three lithospheric plates: Nubia/Somalia (or Africa) plate to the West, India-Australia plate to the East, Antarctica plate to the South.

- Starting from the triple junction, the *Central Indian Ridge* shows a S-N direction, before bending to the NW (thereafter named *Carlsberg Ridge*) and, ultimately, penetrating with a western orientation, after the offset of the Owen transform fault/fracture zone, into the Gulf of Aden; its spreading rate is of some 3 cm/year.
- The *Southwest Indian Ridge* takes a SW direction as far as an extensive set of fracture zones (of some 1 200 km length) which offsets the ridge axis, near the 30° E meridian. Beyond this fracture zone, the ridge turns towards West, and this segment is characterized by a very slow spreading rate, lower than 2 cm/year. One can note that the SW Indian Ridge thins towards its eastern extremity, a consequence of its progressive stretching near the triple junction.
- The *Southeast Indian Ridge has a* general NW-SE orientation. It is the fastest of the three ridges, with a spreading rate of some 7 cm/year.

On the map, it is easy to visualize the variation of spreading rates of the three ridges from the width of the colored strips located on either side of the axes; these bands represent the area of oceanic floor generated by the ridge during a specific time lapse.
If the spreading direction is roughly at right angle to the ridge axis, it is not always the case. The numerous thin black arrows that overprint the ridge axes, give the spreading direction, and their length is proportional to the spreading rate. They clearly underscore the variability of the velocity and direction of the expansion along the axes of each ridge.

OVERVIEW OF THE OPENING OF THE INDIAN OCEAN AS EVIDENCED BY THE MAGNETIC ANOMALIES

The Indian Ocean begins to open by the time of *magnetic anomaly M25* (ca.156 Ma, Late Jurassic), age of the oldest anomaly known in this ocean. A little bit before, a crack occurred on the Gondwana, followed by the settling of a spreading ridge moving apart from Africa an important continental raft, drifting to the SE, and comprising Madagascar, India, Australia and Antarctica. These early days of the formation of the Indian Ocean are visible in the western part of the map where the oldest oceanic crust is to be found (grey-blue color).

An oceanic crust of the same age is still present on the other side of the map, to the NW of Australia. It corresponds to the parting of Australia from a continental sliver that disappeared, probably during the collision of India with Eurasia.

Then, by ca. 120 Ma (Early Cretaceous), time of *anomaly M0*, the accretionary ridge of the Somali Basin, cause of the movement of that block, stopped definitively its activity; Madagascar had reached, then, its present position. The track of the shift of this large island and associated continents is noticeable in the Mozambique Channel, between Africa and Madagascar, where it is marked by the Davie fracture, with a roughly N-S orientation.

By 83 Ma (Late Cretaceous), time of *anomaly 34* – the oldest in the Mascarene Basin , to the East of Madagascar -, India splits off from Madagascar and starts its northward drift. This movement speeds up from the time of *anomaly 31* (70 Ma, Late Cretaceous) onwards. The ridge of the Mascarene basin stops functioning around *anomaly 28* (62 Ma, Paleocene), and the Central Indian Ridge takes over.

India comes into contact with Eurasia at the time of *anomaly 22,* around 50 Ma (Eocene) inducing the uplift of the Himalayas. Two morphostructures, quite conspicuous on the map, the *Chagos-Laccadive Ridge* and the *Ninety East Ridge,* constitute the best evidence of India's northern drift, as they delineate two tracks left by this displacement.

A very important change in the direction of the spreading occurs for the Central Indian and Southeast Indian Ridges between *anomaly 21* (48 Ma) and *anomaly 18* (40 Ma). The spreading direction changes from the NE-SW to the N-S.

To the East of the Ninety East Ridge appears an extinct spreading ridge that was active until the time of *anomaly 18* (40 Ma, Eocene). This part of the East Indian Ridge jumped to the South, driving apart Australia from Antarctica.

The axis of each one of the ridges is affected by the more or less important offsets of the fracture zones. The largest one occurs on the Southwest Indian Ridge, as seen above, and cuts deeply into the oceanic basement so that the seafloor passes abruptly from 2500 m to more than 6000 m depth. Indeed, these fracture zones play a very important role in the circulation of deep-sea waters, in that they form a breach through the submarine ridges (that normally impede the circulation of the bottom waters), and therefore allow the circulation of the cold Antarctic waters, very rich in nutriments and micro-organisms that allows the thriving of the marine feeding chain.

SEISMICITY

Seimicity is a very important geophysical parameter for the knowledge of the current regional geodynamics . It underlines the limits of the lithospheric plates (spreading axes, transform faults, subduction zones, collision) and also active intraplate rifting. Therefore, earthquakes epicenters (symbolized by open lozenges) are both plotted onshore and offshore. The interval of time considered refers to the last 4 decades (1959-2002). In order to ensure an acceptable legibility of the background data, only 4 categories of magnitude have been selected, whose symbol size is increasing accordingly: 5.0-5.9; 6.0-6.9; 7.0-7.9; 8.0 and greater. The 4 categories of focal depths represented on the map (0-35 km; 36-70 km; 71-300 km; 301-700 km) are discriminated by the colour of the symbol.

As said above, these earthquakes are not haphazardly distributed, they underline accurately the accretionary ridge axes and the associated transform faults. In the first case, seismicity is generated by tensional stress exerted by the injection of magma at the axis of the ridge (this process being called "oceanic accretion"), and in the second case, by shear stress due to opposite horizontal movements along the transform fault. These two types of earthkaques are generally shallow and of low magnitude.

A high concentration of earthquakes occurs in the northeastern corner of the map, along the Sunda island arc. This structure is the unique *large* active subduction zone of the Indian Ocean[7], the oceanic crust of the Indian Ocean being underthrust beneath the Eurasia plate. The friction occurring at the interface between the two plates produces important stresses that generate seismicity during their relaxation, and features what is called a "Wadati-Benioff zone". In this region, the sloping subducted slab generates the whole range earthquakes magnitude and focal depth.

Farther to the North of the Sunda subduction, and to the East of India, the seismicity of Burma is more scattered, and corresponds, for most of them, to deep crustal fractures.

On the other hand and North of India, we can see a regular alignment of earthquakes that marks the still currently active push of the Indian block beneath the Himalayas. Likewise, the seismicity of the Zagros Mountains, in Iran, expresses the thrust of the Arabia plate underneath Eurasia.

The seismic line of the accretionary axis of the gulf of Aden, extends onshore in Africa, in the Afar triangle, a part, branching to the north with the rectilinear spreading axis of the Red Sea, the other one bending southwards and following the Great Rift Valley which is lined by the East African Great Lakes (Turkana, Albert, Edward, Kivu, Tanganyika, Rukwa, Malawi). This latter group of earthquakes underline, on the African continent, the boundary between a Nubia plate (i.e. most of Africa) and, to the East, a Somalia sub-plate. Nevertheless, from the Zambesi's mouth southwards, this seismic line disappears offshore which means that, for the time being, the huge rifted tear originating in the Afar triple junction does not extends much farther. One can assume that, if the propagation of the rifting process is not hampered in the (geological) future, it will reach the axis of the Southwest Indian Ridge, and consequently, individualize a full Somalia lithospheric plate from the Nubia/Africa one, with an oceanic seaway in between, several millions years after.

It is interesting to note that, offshore and quite unusually in an intraplate context, a swarm of 11 earthquakes is concentrated very close to the McDonald & Heard islands, on the Kerguelen Plateau

GEODYNAMIC SKETCH

A «Geodynamic sketch», placed as inset on the NE corner of the sheet, presents an overview of the geodynamic pattern of the whole area and, particularly, the extension of each lithospheric plate (each one with a distinct color) within the frame of the map . It shows also the peculiar trail, from about 65 Ma (Deccan traps) to Present (La Fournaise shield volcano), of the imprint of the deep-rooted Réunion hot spot on the northward moving lithosphere: Deccan basalts, Laccadive, Maldives, Chagos, Nazareth Bank, Mauritius, and Réunion (with la Fournaise shield volcano); this track being offset by the Central Indian Ridge in Late Eocene.

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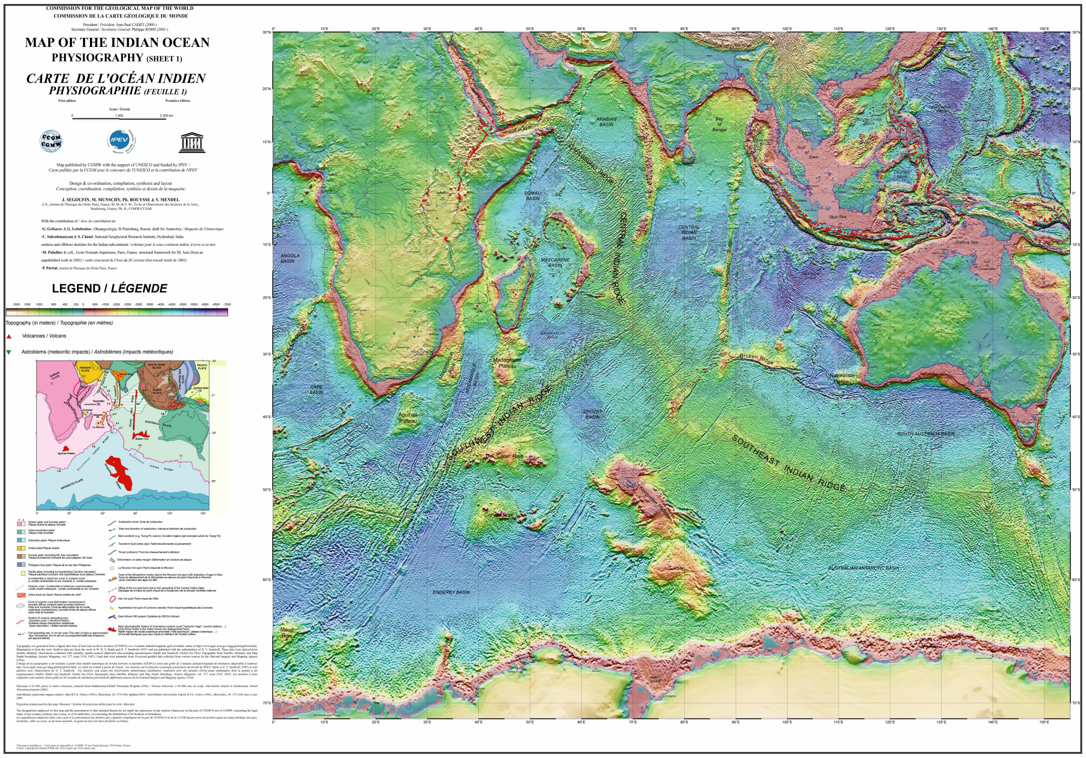
[7] The other is the Makran subduction, much more smaller (cf. "Subduction zones"); its seismicity is more diffuse, and mainly scattered on the sedimentary accretionary prism of which the greatest part is emerged.

LA CARTE DE L'OCÉAN INDIEN
Cartographie physiographique et structurale d'un océan



*RÉSUMÉ - Les deux feuilles qui constituent la C*arte de l'Océan Indien *représentent une synthèse de l'ensemble des données géophysiques et géologiques acquises dans l'océan Indien depuis de nombreuses années, elles permettent d'avoir une vue synthétique sur l'histoire et la structure de cet océan.*

Sur la Carte Physiographique *(Feuille 1) on a reporté la bathymétrie, l'image des reliefs des fonds de l'océan Indien et des terres émergées, les volcans récents et les cratères d'impact météoritique. C'est également sur cette feuille que figure la toponymie.*

Sur la Carte Structurale *(Feuille 2) on a représenté, outre une cartographie simplifiée du fond géologique des terres émergées environnantes:*

- *L'âge de la croûte océanique déduite de l'identification des anomalies du champ magnétique terrestre.*
- *Les anomalies magnétiques dessinées sur la carte à l'emplacement où elles ont pu être mesurées et identifiées.*
- *Les axes d'accrétion océanique, les failles transformantes et les zones de fracture, les anomalies du relief sous-marin, et les zones de subduction qui modèlent le fond des océans.*
- *Les séismes terrestres et sous-marins, et les principales zones de fracture affectant la croûte océanique figurent également sur cette feuille.*
- *Les forages en mer profonde qui ont atteint le socle basaltique, repérés par leur numéro.*
- *Enfin des courbes d'iso-épaisseur des sédiments figurent, là où l'information était suffisamment dense pour permettre leur tracé.*

AVANT-PROPOS

Dans les années 1980, la CCGM a co-publié avec l'UNESCO, et pour la première fois, les cartes des cinq océans de la planète (comprenant l' "océan Antarctique") inclus dans l'*Atlas Géologique du Monde*, à petite échelle. Deux décennies se sont écoulées et notre connaissance de la nature du fond des océans a progressé de manière très significative, et la Commission a décidé, il y a six ans, de mettre en chantier un nouveau type de programme de cartographie du fond d'un océan. La *Carte de l'Océan Indien*[8], parue en août 2004 pour le 32ème Congrès Géologique International de Florence, est la première de cette nouvelle série des cartes. Cette carte a bénéficié, pour sa réalisation, d'un soutien financier de l'UNESCO et de l'IPEV (Institut Paul Emile Victor).

8 Auteurs de la carte: Jacques Ségoufin, Marc. Munschy, Philippe Bouysse et Véronique. Mendel avec la collaboration de Garrik Grikurov & German Leitchenkov (Russie), Challa Subrahmanyan & Shyam Chand (Inde), Manuel Pubellier (France), et Phillippe Patriat (France).

COMMENT CARTOGRAPHIER UN OCÉAN ?

Réaliser la carte d'un océan en essayant de synthétiser de la manière la plus appropriée ses caractéristiques principales dans le domaine des sciences de la Terre, n'est pas un exercice aussi facile qu'on pourrait le penser. En voici les raisons:

- La carte ne peut pas être une *carte géologique,* au sens strict du terme, c. à d. représentant la nature des formations affleurantes (ou sub-affleurantes) comme c'est le cas pour les cartes géologiques régulières levées à terre. Sinon, la plus grande partie des surfaces sous-marines serait représentée par des sédiments plio-quaternaires.
- La carte ne peut pas correspondre, non plus, à une carte tectonique en raison de l'évolution spécifique de la lithosphère océanique dont l'age ne dépasse jamais les quelque 200 Ma[9]
- La carte n'est pas la simple cartographie d'un paramètre géophysique (carte de la sismicité, des différentes anomalies gravimétriques, du flux de chaleur,…).
- La carte devrait inclure des éléments de la géologie des terres émergées (continents environnants et îles disséminées au sein de l'océan), alors que ce n'est pas le cas, jusqu'à présent, pour la plupart des cartes consacrées aux océans. En effet, de telles informations sont susceptibles d'apporter un éclairage complémentaire à la compréhension de l'évolution du bassin océanique, comme par exemple la correspondance des boucliers précambriens de part et d'autre du bassin océanique, ou la relation d'une subduction avec l'arc volcanique correspondant.
- Enfin, la carte ne peut pas être le simple empilement des donnés géologiques et géophysiques qui décrivent cet océan. Une sélection raisonnée de ces dernières est indispensable pour éviter qu'une telle accumulation ne compromette un équilibre acceptable entre lisibilité et niveau d'information.

Pour toutes ces raisons, nous avons choisi de dénommer ce type de concept cartographique, "*Carte Structurale*", un terme qui n'est pas trop connoté sémantiquement.

En ce qui concerne la taille de la carte imprimée, l'expérience nous a conduits a adopter un format raisonnable, car de trop grandes dimensions occasionnent de nombreux inconvénients: limitation due à la taille des presses, problèmes de manutention et d'espace pour le stockage et l'affichage mural, nécessité de proposer un prix de vente attractif. C'est pourquoi l'échelle finale d'impression est le 1/20 000 000 (à l'équateur), soit deux fois plus petite que celle qui a été utilisée pour réaliser la maquette. La projection choisie est celle du système de Mercator, généralement adopté par la communauté des spécialistes qui travaillent en mer. En conséquence, la limite sud de la Carte a été fixée à 71° S, ce qui permet d'éviter la trop grande déformation des surfaces cartographiées en direction du pôle sud, tout en conservant une frange littorale significative du continent Antarctique, bordure méridionale de l'océan Indien. Pour des raisons de clarté, la *Carte Structurale* est constituée de deux feuilles, Feuille 1 : *Physiographie* qui constitue en quelque sorte l'introduction à la carte principale représentée par la Feuille 2 : *Carte Structurale* (*stricto sensu*).

[9] Ma = million d'années

FEUILLE "PHYSIOGRAPHIE"

Comme on vient juste de le faire remarquer, il aurait été très difficile d'ajouter sur la feuille principale ("Carte Structurale") quelque information complémentaire que ce soit. D'un autre côté, les bases de données géophysiques internationales permettent maintenant de produire des images "physiographiques numérisées" à grain très fin", de la morphologie des fonds marins et des terres émergées, avec des reliefs colorés et ombrés, de grande valeur informative et esthétique. Ces deux considérations ont motivé notre décision d'accompagner la Carte Structurale par une Carte Physiographique que cette dernière introduirait.

Sur ce fond physiographique, nous avons rajouté 4 types de données ne produisant qu'une consommation minimale d'espace cartographique, afin de préserver autant que possible la qualité de la représentation des reliefs :

- Une sélection d'isobathes dessinées avec un trait très fin comprenant les contours – 200 m, – 1000 m puis tous les 1000 m.
- La totalité des volcans actifs où ayant fonctionné à l'Holocène[10] (période couvrant, en gros, les derniers 10 000 ans), à terre, et marqués par un petit triangle rouge. Cela représente quelque 300 appareils éruptifs, extraits des fichiers de la Smithsonian Institution (Washington D.C., USA). Ils sont essentiellement concentrés sur l'arc de la Sonde (Indonésie) et en Ethiopie, située sur le Grand Rift Est-Africain.. En rapprochant les feuilles 1 et 2, on notera, pour cette dernière région, l'excellente concordance entre la distribution des appareils volcaniques récents ou actifs et la ligne dessinée par les épicentres des séismes. Par contre, aucun volcan n'est associé à l'importante sismicité de collision localisée au nord de l'Inde, dans l'Himalaya. À l'intérieur de l'océan Indien, les seuls volcans à activité éruptive historique[11] sont : le Karthala (Grande Comore); les volcans Heard et McDonald situés au SSE des îles Kerguelen; le volcan de l'îlot St-Paul (du groupe St-Paul &Amsterdam) sur la dorsale Sud-Est Indienne; et, bien sûr, le Piton de la Fournaise, à la Réunion, un des volcans les plus actifs de la planète.
- Quelque 40 astroblèmes (ou cratères d'impact météoritique), localisés principalement sur le vieux continent australien et marqués par un petite triangle vert à pointe inversée; ils ont été sélectionnés à partir des données du Planetary & Space Science Center of the New Brunswick University (Canada).
- Des éléments de toponymie : villes, fleuves, îles, et principales morphostructures sous-marines. Ces dernières avec une dénomination agréée par les instances *ad hoc* de l'Organisation Hydrographique Internationale.

FEUILLE "STRUCTURALE"

TERRES ÉMERGÉES

L'océan Indien résulte de l'éclatement du supercontinent Gondwana, qui a commencé à se produire au début du Jurassique (en gros vers 200 Ma) et conduisant à la

[10] Le début de l'Holocène qui était fixé jusqu'à présent à 10 000 ans B.P., vient d'être officiellement déplacé à 11 500 ans B.P.

[11] La notion d'activité historique (c.à d. consignée dans des écrits plus ou moins contemporains des éruptions) est élastique. Pour la zone de l'océan Indien, elle est rarement antérieure au XVII^{ème} siècle.

dispersion ("dérive") de blocs continentaux de tailles diverses : Afrique, Inde, microcontinent des Seychelles[12], Madagascar, Australie, Antarctique, Arabie (et aussi Amérique du Sud, qui ne concerne pas l'océan Indien mais l'ouverture de l'Atlantique Sud). On discute encore de la nature de l'Agulhas Plateau (Plateau des Aiguilles) situé en face de la pointe de l'Afrique du Sud : relief de croûte océanique anormale ou microcontinent ? Cette dernière hypothèse a été adoptée par les auteurs de la *Tectonic Map of the World* publiée en 1985 par Exxon et réédité en 1995 par la Geological Society of America (GSA).

LES DOMAINES CONTINENTAUX SONT TRES SCHEMATIQUEMENT REPRESENTES PAR :

Des zones cratoniques (boucliers anciens) archéennes et protérozoïques (ou du Précambrien indifférencié).

Des bassins ou plates-formes phanérozoïques (c. à. d. du Paléozoïque à l'Actuel).

Des ceinture orogéniques du Paléozoïque (p. ex. à l'extrémité de l'Afrique du Sud), du Mésozoïque (p.ex. la péninsule Malaise), et du Cénozoïque (p. ex. l'Himalaya, fruit de la collision entre l'Inde et l'Eurasie, qui a commencé vers environ 50 Ma. Quand plusieurs orogenèses se sont succédé au même endroit, c'est le dernier grand cycle orogénique qui a été pris en compte ici.

Le volcanisme méso-cénozoïque qui a accompagné différentes étapes de l'évolution de l'océan Indien est subdivisé en unités chronologiques (horizontales dans la légende) et en trois grands domaines géodynamiques (verticaux dans la légende) :

- *Volcanisme de rift et/ou de point chaud* bien défini. Les *trapps* du Deccan qui se sont épanchés à l'extrême fin du Crétacé (vers 65 Ma), correspondent à la tête d'un puissant point chaud qui opère actuellement, avec un débit beaucoup moins puissant, sous l'île de la Réunion. On trouve en Inde deux autres témoins d'un volcanisme de point chaud actif au Crétacé inférieur (vers 120 Ma) : ceux de Rajmahal et de Sylhet, situés respectivement au NNW et NNE du delta du Gange-Brahmapoutre. Dans le cas du volcanisme néogène du Grand Rift Est-Africain et d'Arabie, il est pour l'instant prématuré – étant donné l'échelle de la carte et l'état de levés géologiques régionaux – de discriminer graphiquement entre le volcanisme de trapps d'Ethiopie et du Yémen qui s'est épanché vers 30 Ma, et le volcanisme lié à l'ouverture subséquente du Rift Est-Africain et à l'ouverture de la Mer Rouge (volcanisme de "Harrats" d'Arabie Saoudite).
- *Volcanisme de subduction cénozoïque (cf. infra* "Zones de subduction") caractérisant la centaine de volcans actifs ou récents de l'arc de la Sonde qui est implanté sur un bord de la mégaplaque Eurasie, et sous lequel plonge une croûte océanique, appartenant à la plaque Inde-Australie, et d'âge varié (du Jurassique supérieur à l'Eocène).
- *Volcanisme de nature non spécifiée*, comme le volcanisme quaternaire du sud-est de l'Australie (Etat de Victoria) qui n'a pas été, jusqu'à présent, rattaché à un mécanisme géodynamique clairement défini.

Les ophiolites résultant de l'*obduction* (en Oman, au Crétacé supérieur) ou du piégeage de morceaux de lithosphère océanique dans les *zones de suture* lors de collisions (p. ex. dans la chaîne du Zagros, en Iran) ont été cartographiées. Une indication de l'âge de la croûte océanique en question est donnée, quand il est connu.

Les éléments tectoniques sont indiqués par des failles (normales, de coulissage – comme celle de Semangko qui traverse tout Sumatra –, et non spécifiées) et par des chevauchements de premier ordre, comme le Chevauchement Frontal Himalayen .

DOMAINE ANTARCTIQUE

L'Antarctique a fait l'objet d'un traitement cartographique particulier en raison de l'existence d'un immense inlandsis. Seuls les affleurements, disséminés sur les zones côtières, ont été cartographiés "conventionnellement" (essentiellement des formations précambriennes). Sous la calotte glaciaire, la morphologie du substratum rocheux est suggérée par des courbes de niveau (positives ou négatives par rapport au niveau de la mer) ont été sélectionnées tous les 500 m. On voit, ainsi, qu'une partie importante de ce continent, qui subit l'énorme surcharge glaciaire, est enfoncée sous le zéro marin, particulièrement le graben d'Amery (vers 70° -75° E) et à l'est. Cette surcharge se marque également sur le plateau continental dont l'extension, ici, n'est pas limitée par l'isobathe –200 m, mais à un niveau plus bas (d'où la formulation dans la Légende : "Limite externe de la plate-forme circum-antarctique"). Le vrai trait de côte et la limite externe du"shelf glaciaire[13]" (c. à. d. de l'extension en mer de la calotte glaciaire) sont représentés par deux figurés différents.

DOMAINE SOUS-MARIN

ÂGE DE LA CROÛTE OCÉANIQUE ET ANOMALIES MAGNÉTIQUES

On rappellera que les laves, en piégeant de façon durable - au cours de leur refroidissement -, la direction et l'intensité du champ magnétique terrestre, permettent de dater le plancher océanique qui est constitué de basalte. C'est ainsi que l'on a pu établir une échelle chronologique des inversions du champ magnétique, qui a permis d'identifier un certain nombre *d'anomalies magnétiques* caractéristiques auxquelles on pouvait attribuer un âge. C'est donc à partir de la localisation et de l'identification des anomalies magnétiques que l'on a pu dater le plancher océanique et mettre en évidence le processus de *l'expansion des fonds océaniques*.

Le premier élément pertinent à prendre en considération dans la cartographie "géologique" d'un océan, est l'âge de la croûte océanique formant le substratum des grands fonds marins. Dans la Carte, ce sont les *âges chronostratigraphiques* (ici, les "époques" avec leurs couleurs conventionnelles, la couleur grise indiquant un âge non encore déterminé avec précision) qui sont représentés, et non pas les âges géomagnétiques (ou "chrones", correspondant à la chronologie des anomalies magnétiques et utilisés par les géophysiciens. En effet, nous avons fait ce choix afin d'être en cohérence avec l'échelle chronologique

[12] Petit bloc continental constitué de granites protérozoïques, détaché de l'Inde au Crétacé supérieur ; la plus grande île,de ce petit archipel granitique est Mahé (144 km^2,où se trouve la capitale Victoria. Les îles des " Seychelles Coralliennes ou Éloignées » comme les Almirantes, Farquar, ou Aldabra, ont été édifiées sur un substratum de croûte océanique.

[13] À ne pas confondre avec la banquise qui résulte de la congélation de quelques mètres, ou décimètres, d'eau de mer.

des événements géologiques. Ces âges géologiques de la croûte océanique ont été cartographiés par interpolation calculée à partir des données numérisées des anomalies magnétiques de Müller *et al.* (1997). Cependant, nous avons tenu à reporter la localisation exacte des points de mesure des anomalies enregistrées par les magnétomètres embarqués. Dans la Légende, est fourni un tableau donnant la liste de chaque anomalie standard (ou chrone) et de son âge, d'après l'échelle géomagnétique de Cande & Kent (1995), pour les chrones 1o (0,78 Ma) à 33 o (79,075 Ma), et celle de Gradstein *et al.* (1994) pour les époques plus anciennes. Ces points sont figurés par un petit cercle évidé rempli par une couleur spécifique à chaque magnétochrone.
Comme éléments structuraux de la croûte océanique, on a représenté : les *axes des dorsales d'accrétion océanique*, avec indication, localement, du taux global d'expansion en cm/an; occasionnellement les *axes des dorsales d'expansion fossiles* (comme dans le bassin de Somalie); les *failles transformantes* et les *zones de fracture* qui les prolongent.

ANOMALIES DU RELIEF SOUS-MARIN

Les reliefs correspondant à un soubassement volcanique anormal (*monts sous-marins, rides "asismiques", "plateaux océaniques", ou structures de nature incertaine ou controversée* comme le plateau des Kerguelen : résultant d'un point chaud ou croûte d'origine continentale ?) sont signalés par une couleur vert-jaune pâle. Un des exemples les plus remarquables est celui de la "Ninety East Ridge" (dénommée ainsi, car plus ou moins centrée sur le méridien 90° E) qui dessine une morphostructure remarquablement rectiligne, tirant son origine de la dérive du bloc de l'Inde vers le nord, avant sa collision avec l'Asie.

ZONES DE SUBDUCTION

Une longue zone de subduction (de plus de 6000 km) borde *l'arc insulaire de la Sonde* (Indonésie). En effet, la croûte océanique de l'Océan Indien, relativement froide, est réchauffée en s'enfonçant dans le manteau asthénosphérique, (plus plastique), puis se déshydrate, ce qui provoque une fusion partielle de ce manteau sus-jacent qui conduira à la formation du magma des volcans de l'arc. La zone de subduction a été marquée par une ligne rouge portant des triangles pleins, de même couleur. Les vecteurs de la subduction (en cm/an) montrent une orientation NNE de la convergence relativement frontale devant l'ouest de Java, et très oblique au nord de l'extrémité nord-ouest de Sumatra. C'est cette obliquité qui a généré la grande faille de coulissage (dextre) de Semangko qui coupe Sumatra sur toute sa longueur. C'est cette même géométrie de la subduction qui produit, un peu plus au nord, l'expansion active du petit bassin marginal des Andaman créé au Néogène, puis le mouvement transformant qui relie l'arc de la Sonde aux grandes failles de coulissage de Birmanie. Ce bassin arrière-arc a été cartographié avec sa croûte océanique d'âge, ses petits axes d'accrétion océanique et ses failles transformantes.

On notera devant les côtes septentrionales des îles de la Petite Sonde (à l'est de 120° E) l'existence d'une zone de subduction naissante (indiquée par une ligne avec des triangles rouges évidés) qui fait plonger, vers le sud, la croûte océanique de la mer de Banda sous l'arc volcanique. Cette nouvelle subduction qui accommode le début de collision de l'Australie avec l'arc de la Sonde qui, par ailleurs, provoque la surrection de Timor et de Sumba et des petites îles voisines, coincées entre ces deux blocs.

Une autre zone de subduction, de taille beaucoup plus réduite (environ 900 km), est en activité devant les côtes du Baluchistan (à cheval sur l'Iran et le Pakistan), c'est *la subduction du Makran*. La croûte océanique crétacée– appartenant ici à la plaque Arabie (qui est limitée à l'ouest par la faille transformante d'Owen) – s'enfonce, suivant une direction NNE, sous le bloc iranien (rattaché à l'Eurasie) ; cette subduction engendre un prisme d'accrétion sédimentaire de plusieurs kilomètres d'épaisseur, en grande partie émergé, et plus en arrière, un petit arc volcanique comprenant quelques appareils actifs à l'Holocène (dont le Taftan).

FORAGES EN MER PROFONDE

Parmi les forages océaniques profonds réalisés par les consortiums scientifiques internationaux (DSDP, IPOD, ODP, IODP), seuls ceux qui ont atteint le socle basaltique ont été représentés sur la Carte. Ces forages sont très importants car il est possible, à partir des carottes prélevées, de dater les échantillons de basalte par des méthodes utilisant des isotopes radioactifs, et surtout les sédiments reposant directement sur le basalte grâce à la microfaune qu'ils contiennent. Dans ce dernier cas, l'âge de la croûte océanique ne peut être qu'antérieur à l'âge du sédiment qui s'est déposé par dessus. Les âges obtenus grâce à ces forages ont permis de contrôler l'âge de la croûte océanique donné par les anomalies magnétiques et de valider l'hypothèse de l'expansion des fonds océaniques à partir de l'axe d'une dorsale. Ces forages sont indiqués par une étoile noire et leur numéro.

ÉPAISSEUR SÉDIMENTAIRE

Les informations concernant l'épaisseur des sédiments recouvrant le plancher océanique sont très peu nombreuses. Les zones pour lesquelles il y a eu suffisamment de données pour tracer des courbes d'iso-épaisseur de sédiments concernent essentiellement les marges continentales de l'Inde, de l'Afrique de l'Est et de l'Antarctique. L'épaisseur est indiquée par une surimpression de trame grisée dont l'intensité croît de 0 à 15 km Les fortes épaisseurs constatées à l'est et à l'ouest de l'Inde, sont dues à l'apport de l'alluvionnement sédimentaire important des deux systèmes fluviatiles drainant l'Himalaya : celui de l'Indus (4 km), et surtout celui du Gange-Brahmapoutre (jusqu'à 14 km !). On notera aussi un fort recouvrement (jusqu'à 9 km) en contrebas de la marge continentale depuis le sud de la Somalie jusqu'au sud de la Tanzanie. Dans ce dernier cas, cette forte épaisseur ne peut être liée à un puissant système hydrographique relativement récent.

ZONE DE DÉFORMATION DE LA CROÛTE OCÉANIQUE

Entre l'Inde et l'Australie, mais plus proche de la première, on trouve une zone où la croûte océanique est déformée sous l'effet de contraintes compressives. En longitude, la zone affectée s'étend de l'axe de la dorsale Centrale Indienne à la zone de subduction de Sumatra. Sur la Carte, elle a été marquée par des hachures horizontales en surimpression. Tout ce secteur est aussi caractérisé par une sismicité diffuse ; il pourrait être le signe avant-coureur d'une future zone de rupture conduisant à l'individualisation de deux plaques lithosphériques distinctes.

TRIANGLE DE L'AFAR

Le "triangle" de l'Afar et l'extrémité méridionale de la mer Rouge constituent une région tout à fait particulière qui relie le reste de cette mer étroite, d'océanisation récente (Plio-Quaternaire), au golfe d'Aden qui s'est ouvert un peu plus tôt (Miocène), et au Grand Rift Est-Africain. Dans le triangle de l'Afar, les formations volcaniques terrestres (et cartographiées comme telles) correspondent, en réalité, à une croûte océanique en phase d'accrétion active, soulevée et émergée sous l'action d'un point chaud dont l'action a commencé à s'exercer vers la fin de l'Oligocène (cf. supra, les trapps d'Ethiopie) La position supposée des axes d'accrétion océanique y est indiquée par un tireté vert.

MARGES CONTINENTALES

La marge continentale représente la frange du continent qui est recouverte par la mer. Elle comprend la plate-forme continentale –dont la limite est plus ou moins arbitrairement fixée à l'isobathe –200 m, et la pente continentale qui se raccorde, vers environ – 3000 m, aux fonds sous-marins à substratum de croûte océanique. Le plateau continental est représenté par la couleur blanche, et la pente continentale par une teinte bleu pâle. Comme les arcs insulaires correspondent à une croûte continentalisée par les processus magmatiques issus de la subduction, leur extension sous-marine a été traitée de la même manière que les marges continentales proprement dites.

MORPHOSTRUCTURES LES PLUS VISIBLES SUR LA CARTE : LES TROIS DORSALES D'EXPANSION

L'océan Indien s'est créé, petit à petit, à partir de la fragmentation du supercontinent Gondwana., puis de la dérive, complexe au cours du temps, des nombreux blocs le constituant qui, sous l'effet de l'activité des dorsales à l'axe desquelles s'injecte la lave (qui va constituer le plancher océanique), vont s'éloigner les uns des autres.

L'océan Indien est caractérisé par la présence de trois dorsales, dont les vitesses d'expansion, équivalentes à la quantité de lave émise à leur axe durant une même période, sont très différentes. Ces trois dorsales ont un point commun, *le point triple* de Rodrigues, situé à 70° E et 26° S, près de l'île du même nom. Elles constituent les limites de trois plaques : Plaque Nubie/Somalie (ou Afrique) à l'ouest, Plaque Inde-Australie à l'est, et Plaque Antarctique au sud.

La branche *Centrale Indienne* a d'abord une direction S-N, puis s'incurve en s'orientant vers le NW (elle prend alors le nom de *dorsale* ou *ride de Carsberg*), et enfin se dirige vers l'W en pénétrant dans le golfe d'Aden, après décalage par la faille transformante (et zone de fracture) d'Owen; son taux d'expansion moyen est de l'ordre de 3cm/an.

La branche *Sud-Ouest Indienne*, a une direction SW jusqu'à un ensemble très important de zones de fracture qui décale l'axe de la dorsale de plus de 1200 km, au niveau du méridien 30° E. Après ce grand accident, la dorsale prend une direction W ; toute cette branche a une vitesse d'expansion très faible, inférieure à 2 cm/an. On notera qu'elle s'amincit vers son extrémité orientale, conséquence de son allongement progressif au niveau du point triple.

La branche *Sud-Est Indienne* a une direction générale NW-SE ; c'est la plus rapide des trois dorsales, avec une vitesse d'expansion de l'ordre de 7 cm/an.

Sur la Carte, il est facile d'identifier les différents taux d'expansion des trois dorsales d'après la largeur des bandes colorées situées de part et d'autre de l'axe, et qui représentent la surface de plancher océanique créée par la dorsale durant une période donnée.

Si la direction de l'expansion est *grosso modo* perpendiculaire à l'axe des dorsales, ce n'est pas toujours le cas. Les flèches qui recoupent l'axe tout le long des dorsales indiquent la direction de l'expansion et par leur longueur (module), le taux d'expansion. Elles indiquent très clairement la variabilité de la vitesse et de la direction d'expansion le long des axes de chacune des dorsales.

GRANDS TRAITS DE L'OUVERTURE DE L'OCÉAN INDIEN, INDIQUÉS PAR LES ANOMALIES MAGNÉTIQUES

L'océan Indien commence à s'ouvrir autour de *l'anomalie magnétique M25* (environ 156 Ma, Jurassique supérieur), âge de la plus vieille anomalie identifiée dans cet océan. Un peu avant cette époque, une fracture est apparue dans le supercontinent du Gondwana, puis une dorsale d'accrétion océanique s'est installée, écartant peu à peu de l'Afrique un bloc important comprenant Madagascar, l'Inde, l'Australie et l'Antarctique. Ce bloc s'est mis à dériver vers le SE. Ces débuts de la genèse de l'océan Indien sont visibles sur la partie ouest de la carte où se trouve la croûte océanique la plus ancienne (couleur gris-bleu).

Une croûte océanique de même âge se retrouve au nord-ouest de l'Australie ; elle correspond à la séparation de l'Australie et d'un bloc continental qui a disparu, probablement au cours de la collision de l'Inde avec l'Eurasie.

Puis il y a environ 120 Ma (Crétacé inférieur), époque de *l'anomalie magnétique M0*, la dorsale du bassin de Somalie qui était responsable du déplacement de ce bloc, a cessé de fonctionner ; Madagascar avait alors atteint la position qu'elle occupe actuellement. La trace de ce déplacement de Madagascar et des continents associés est visible dans le Canal de Mozambique, entre l'Afrique et Madagascar, où elle est marquée par la zone de fracture Davie, de direction grossièrement N-S.

Puis vers 83 Ma (Crétacé supérieur), à l'époque de *l'anomalie 34,* la plus vieille anomalie reconnue dans le bassin des Mascareignes situé à l'est de Madagascar, l'Inde se sépare de Madagascar et commence sa dérive vers le nord. Ce mouvement s'accélère à partir de l'époque de *l'anomalie magnétique 31* (70 Ma, Crétacé supérieur). La dorsale du bassin des Mascareignes cesse de fonctionner autour de l'époque de *l'anomalie magnétique 28* (62 Ma, Paléocène), c'est alors la dorsale Centrale Indienne qui prend le relais.

L'Inde entre en contact avec l'Eurasie à l'époque de *l'anomalie 22*, vers 50 Ma (Éocène), ce qui provoque la surrection de l'Himalaya. Deux structures sont bien visibles sur la carte, la *ride des Chagos-Laquedives* et la ride du 90ème Est (*Ninety East Ridge*). Elles constituent les meilleurs témoins du mouvement de l'Inde, formant comme des "rails" créés lors de son déplacement vers le nord.

Un changement très important dans la direction de l'expansion apparaît également pour les dorsales Centrale Indienne et Sud Est Indienne, entre l'époque des *anomalies magnétiques 21* (48 Ma) et *18* (40 Ma). La direction de l'expansion passe d'une direction NE-SW à une direction N-S.

A l'est de la ride du 90ème Est, il existe une dorsale fossile qui a fonctionné jusqu'à l'époque de l'*anomalie magnétique*

18 (40 Ma, Éocène). Cette section de la dorsale Est-Indienne a sauté vers le sud pour séparer l'Australie de l'Antarctique.

L'axe de chacune des dorsales est décalé de façon plus ou moins importante par de nombreuses zones de fracture. C'est sur la dorsale Sud-Ouest Indienne que les zones de fracture sont les plus importantes, certaines décalant l'axe de la dorsale de plus de 1200 km et affectant profondément la croûte océanique, faisant brusquement passer le fond de l'océan de 2500 m à plus de 6000 m de profondeur. En fait ces zones de fracture jouent un rôle très important, car les dorsales forment des chaînes de montagne sous marines qui font obstacle à la circulation des eaux profondes ; les zones de fracture, en créant des passages, permettent la circulation des eaux de fond, notamment des eaux froides antarctiques, très riches en micro-organismes dont se nourrissent les poissons.

SISMICITÉ

La sismicité est une donnée géophysique importante pour la connaissance de la géodynamique régionale actuelle. Elle souligne les limites des plaques lithosphériques (axes d expansion, failles transformantes, zones de subduction, collisions,…), ainsi que le rifting intracontinental actif. C'est la raison pour laquelle les séismes, symbolisés par des losanges évidés, ont été reportés en mer comme à terre.

Les épicentres des séismes ayant eu lieu de 1959 à 2002 ont été représentés sur la Carte. Pour ne pas surcharger cette dernière par une abondance de données qui en compromettrait la lisibilité, seuls les séismes d'une magnitude supérieure ou égale à 5,0 ont été retenus et classés en 4 catégories (5,0 ; 6,0 ; 7,0 ; 8,0et au-delà). Les 4 classes de profondeur à laquelle ils se sont produits (0-35 km, 36-70 km, 71-300 km, 301-700 km) sont différenciées par la couleur du symbole.

Comme l'on vient de le dire, ces séismes ne sont pas distribués au hasard, ils soulignent très précisément l'axe des dorsales et les failles transformantes associées. Dans le premier cas ils sont dus aux tensions créées dans la croûte par l'injection de la lave à l'axe de la dorsale (c'est ce qu'on appelle le phénomène de l'accrétion océanique), et dans le second cas, principalement par des déplacements cisaillants de la croûte provoqués par les failles transformantes. Ces types de séismes sont généralement de faible profondeur et de faible magnitude.

Une forte concentration de séismes existe dans la partie nord-est de la carte, le long de la fosse de l'arc insulaire de La Sonde. Cette structure correspond à la seule grande zone de subduction active[14] de l'océan Indien, là où la plaque Inde s'enfonce sous la plaque Eurasie. Le frottement des deux plaques l'une sur l'autre induit des tensions très importantes dans la croûte qui en se relaxant provoquent des séismes dont l'ensemble désigne ce l'on appelle une *zone de Wadati-Benioff*. Dans cette zone, au fur et à mesure que la plaque, inclinée, s'enfonce, on trouve toute la gamme de magnitude et de profondeur des séismes.

Plus au nord de l'arc de la Sonde et à l'est de l'Inde, les séismes de la région birmane sont beaucoup plus dispersés ; ils marquent essentiellement des accidents profonds qui affectent cette région..

Par contre, au nord de l'Inde, on retrouve un alignement régulier de séismes qui marquent les mouvements qui continuent d'agiter la région himalayenne sous la poussée du bloc indien. De même, en Iran, les séismes qui affectent la chaîne du Zagros traduisent la poussée de la plaque Arabe sous l'Eurasie.

Une ligne de séismes prolongent très nettement la dorsale du Golfe d'Aden sur le continent africain, au niveau de l'Afar, et se branche d'une part au nord, sur l'axe d'expansion de la mer Rouge, et d'autre part forme un alignement, grossièrement nord–sud qui suit la Grande Vallée du Rift, jalonnée notamment par les grands lacs (Turkana, Albert, Edward, Kivu, Tanganyika, Rukwa, Malawi). Ces séismes marquent la frontière, sur le continent africain, entre une plaque Nubie (c. à d. la plus grande partie de Afrique) à l'ouest, et une plaque en voie d'individualisation (ou "sous-plaque") Somalie, à l'est. Cependant, partir de l'embouchure du Zambèze (Mozambique) et vers le sud, la ligne de séparation n'apparaît plus en mer, ce qui signifie que la propagation de cette grande déchirure –qui a débuté au point triple mer Rouge – golfe d'Aden – Grand Rift Africain, ne va, pour le moment, pas au-delà. Si rien ne vient contrarier le processus enclenché, la déchirure se propagera jusqu'à se boucler sur l'axe de la dorsale Sud-Ouest Indienne, achevant ainsi l'individualisation de la plaque Somalie, et dans plusieurs millions d'années, la partie du continent africain située à l'est de l'axe sismique se séparera du reste de l'Afrique : un nouvel océan s'ouvrira.

On notera enfin, en contexte océanique intraplaque, un essaim de 11 séismes concentrés à proximité des îles McDonald et Heard (plateau des Kerguelen).

ESQUISSE GÉODYNAMIQUE

Une esquisse géodynamique a été placée, en encart, sur les deux feuilles. Elle donne une vue simplifiée du cadre géodynamique de l'océan Indien et des terres environnantes. L'extension des différentes plaques lithosphériques concernées par la Carte, est soulignée par un habillage en couleur. Ce schéma montre également le tracé particulier qu'a imprimé le point chaud de la Réunion (considéré comme relativement stable par rapport à un système de coordonnées fixes) depuis environ 65 Ma sur la lithosphère sus-jacente et animée d'un mouvement en direction du nord : basaltes du Deccan, Laquedives, Maldives, Chagos, banc de Nazareth, Maurice, et enfin la Réunion (abritant le volcan actif de la Fournaise). Ce cheminement a été décalé par le passage de la dorsale Centrale Indienne à l'Éocène.

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Novembre 2004

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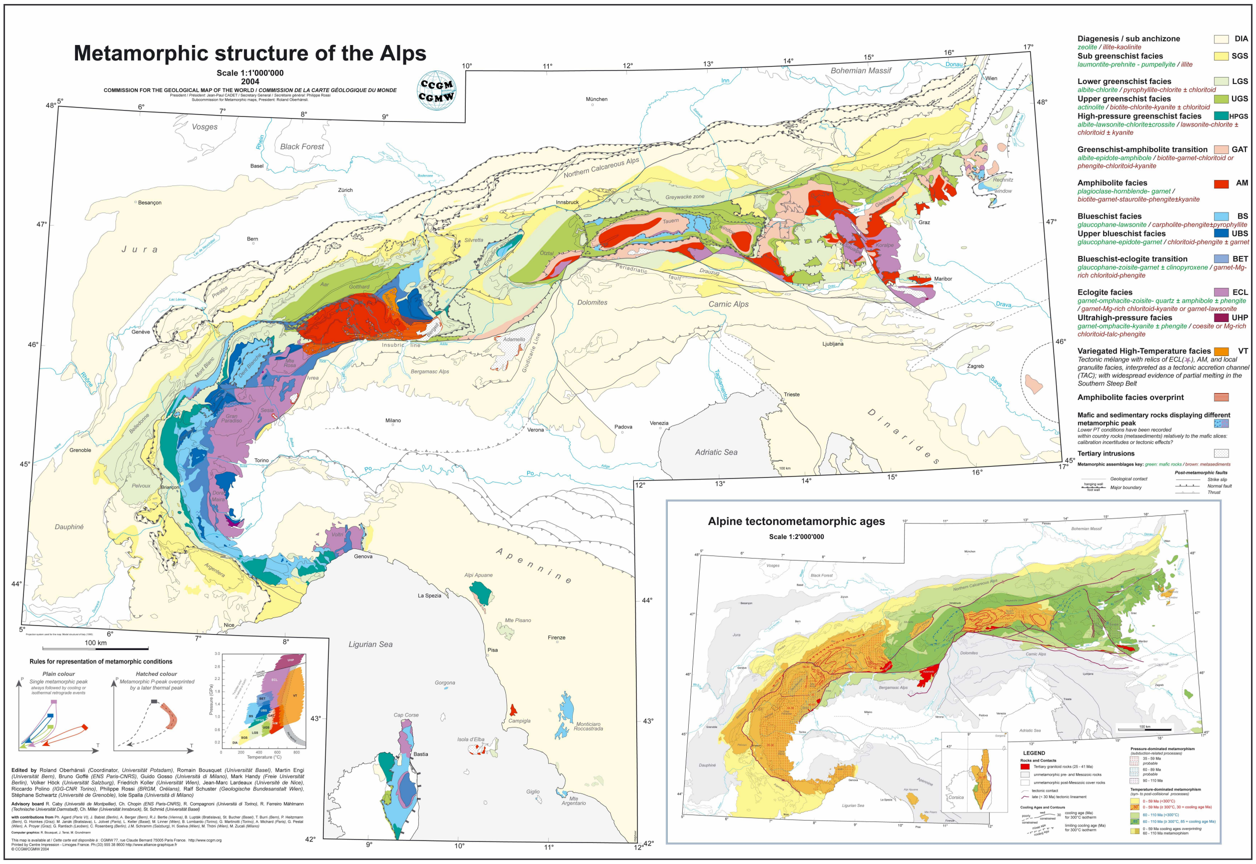
[14] L'autre zone, beaucoup plus petite, est celle du Makran (cf. Zones de subduction). La sismicité est plus diffuse et dispersée surtout sous le prisme d'accrétion sédimentaire dont la plus grande partie est émergée.

MAP OF THE METAMORPHIC STRUCTURE OF THE ALPS

At 1:1,000,000 scale

By R. Oberhänsli and collaborators



This map covers the whole range of the Alps which extends from the Mediterranean shores of Liguria and French Riviera (and of Northeastern Corsica, also called "Alpine Corsica") to the meridian of Vienna that marks the eastern termination of this mountain belt.

The map is the result of cooperative work of Austrian, French, Italian and Swiss Earth scientists who studied for the last three decades in the Alps, the cradle of the science of tectonics. As a matter of fact, by the end of the XIXth century and the beginning of the XX^{th,} precursors such as M. Bertrand, (1884), M. Lugeon (1902), O. Ampferer (1906), or E. Argand (1911), conceived and developed, from their field studies in the Alps, the nappe hypothesis implying the idea of large horizontal movements. The theory of plate tectonics, developed in the 1960', s, provided conceptual tools allowing a better understanding of the mechanisms generating the uplift of mountain belts. The authors of the map investigated the Cretaceous and Cenozoic closing of the Tethyan oceanic realm, the subduction-related processes, and the exhumation of the Alps. The modern techniques of study of mineral transformation underwent by the initial formations, and resulting from the metamorphic processes generated by the geodynamic stresses, provide valuable additional information relevant to the tectonic context. They allow to have a better understanding of the physico-chemical evolution of the environment that characterizes of the history of the orogenic belt formation.

The present map displays more than a simple picture of the metamorphic facies distribution in the Alps, as it was the case for the previous metamorphic maps (cf. e.g. Frey et al., 1999) that didn't take into account the tectonic context and the geodynamic evolution of different regional domains of the Alpine orogen. The authors of the present map had, indeed, a more ambitious purpose since their intention was to show the contrasts in the geodynamic evolution of different regional domains of the Alps. To do so, they should have included kinematic information basedon structural and paleomagnetic data, as well as the age and distribution of flysch sequences. However, the regional distribution of such data is quite uneven and would have hampered the readability of the map. Hence, they decided to concentrate on *the type and grade of metamorphism,* bearing in mind that metamorphism is related to geodynamic processes. This new map shows which units underwent which process, and approximately at what time and to what depth. The choice was made to refer to conditions where pressure and temperature peak were reached simultaneously, or where a temperature peak was reached at lower pressures after a significant temperature increase during the decompression path (shown with hatched areas, in the Central Alps).This cartographic solution allows to see, at first glance, what type of geodynamic process is linked to the main metamorphic structure: subduction in the Western Alps; collision in the Central Alps; a more complex history in the Eastern Alps, involving the succession of the two types of process. Consequently, this new map shows where subduction-, collision-, exhumation-related types of metamorphism are found in the Alps.

The guidelines of this map were to *address only the Mesozoic*-Cenozoic *evolution of the Alps,* all pre-Alpine metamorphic features being omitted. In doing so, the map becomes more legible than all the previous cartographic attempts (see above) because the latter strove to emphasize polymetamorphic and/or plurifacial complexities. In this new publication, the main map (at 1:1,000,000 scale) only shows Alpine metamorphic peak conditions irrespective of when these were attained. Additional data concerning the age of this metamorphism are mapped on an inset map (at 1:2,000,000 scale) entitled "*Alpine tectonometamorphic ages"* with a legend indicating the two main types of metamorphism: 1/ subduction-related (pressure-dominated) metamorphism (from 35 to 59 Ma; 60 to 89 Ma;90 to 110 Ma); 2/ syntectonic and post collision (temperature-dominated) metamorphism (from 0 to 59 Ma with t <300° C; 60 to 110 Ma, t <300° C; with also indications on the cooling ages for 300° C isotherm).

The legend of the main map lists the 15 facies divisions which have been used and based on the different metamorphic assemblages identified in mafic and in pelitic compositions. The color code applied to these 15 metamorphic faces domains have been chosen so that they allow a grouping into 3 main groups of hues linked to the 3 main geodynamic domains: blue to pink/violet tints for subduction-related metamorphic condition; yellow to green, and red colors for continental collisions; red/orange colors for high temperature conditions, which appear to be related to exhumation. As a result, the main map clearly shows a relatively simple picture for the *Western Alps* with an internal high-pressure dominated part thrust over an external greenschist to low grade domain; such a metamorphic pattern is generally produced by subduction followed by exhumation along a cool decompression path. In contrast, *Central Alps* show a typical subduction-related environment followed by an intensely evolved collision process resulting to an heating event during the decompression path of the early subducted units. As to the*Eastern Alps*, they are characterized by subduction-related relics and heating phenomena in different tectonic edifices; this complexity being the result of a dual metamorphic evolution, product of two orogenies, a Cretaceous orogeny followed by a Cenozoic one.

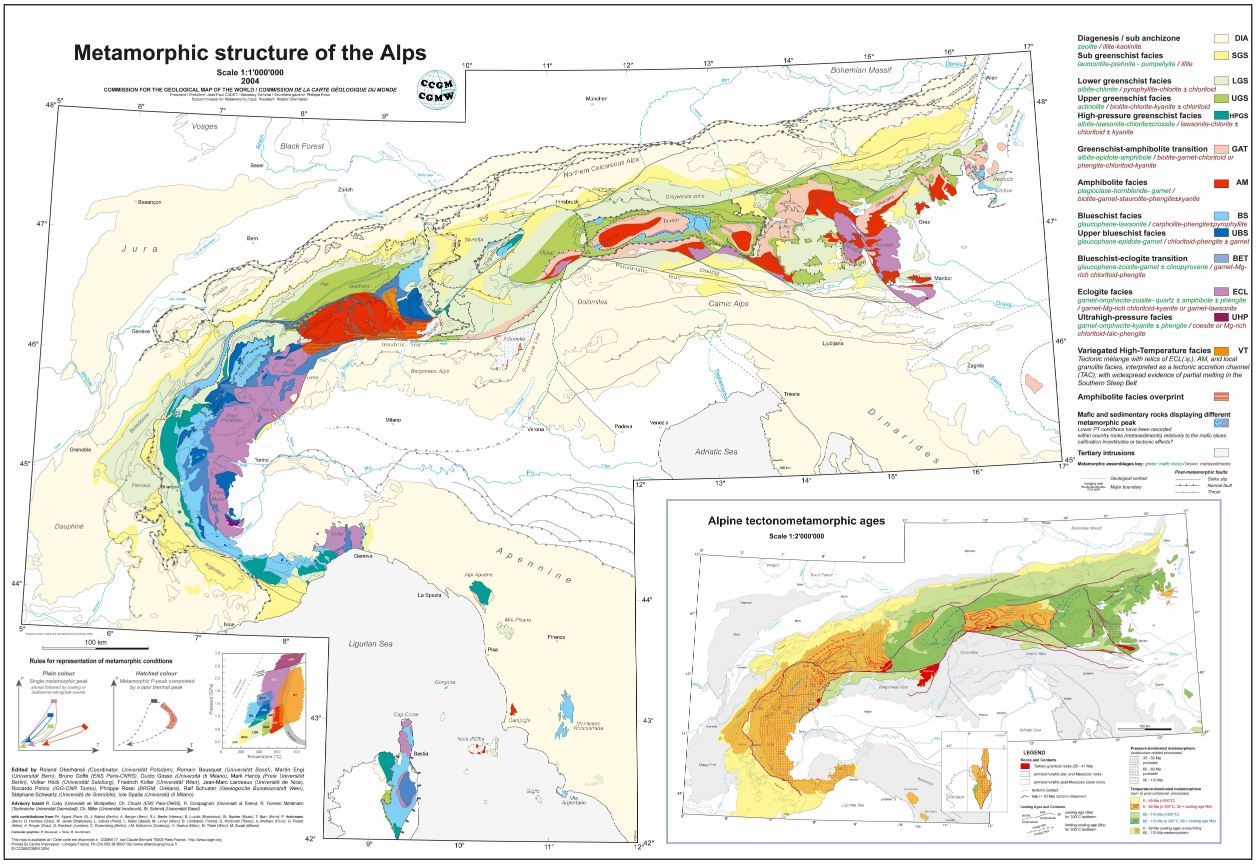
In conclusion, this map allows a relatively easier access to the geodynamic evolution of the Alpine orogenesis.

The *Map of the Metamorphic structure of the Alps* was published by the Commission for the Geological Map of the World in August 2004 (size: 119 cm x 78 cm).)

CARTE STRUCTURALE DU MÉTAMORPHISME DES ALPES

à l'échelle du 1/ 1 000 000

par R. Oberhänsli et collaborateurs



Cette Carte couvre toute l'étendue de la chaîne alpine proprement dite qui s'étend depuis les rivages ligures et niçois de la Méditerranée (et du Nord-Est de la Corse, appelée "Corse alpine") jusqu'au méridien de Vienne qui marque la terminaison orientale des Alpes. Elle est le fruit du travail d'équipes pluridisciplinaires de géologues autrichiens, français, italiens et suisses oeuvrant en étroite collaboration, depuis trois décennies, dans ce berceau historique de la science tectonique. En effet, à la fin du XIX^{ème} siècle et au début du XX^{ème}, des pionniers comme M. Bertrand (1884), M. Lugeon (1902), 0. Ampferer (1906) ou E. Argand (1911) ont conçu la théorie des nappes de charriage impliquant la notion de vastes mouvements horizontaux, à partir de leurs travaux dans les Alpes. Avec le concept de la tectonique des plaques, développé à partir des années 1960, on a pu disposer des outils permettant de mieux cerner les mécanismes qui ont conduit à la surrection des chaînes de montagne. Les auteurs de cette Carte se sont attachés à étudier la fermeture du domaine de l'océan Téthysien au cours du Crétacé et du Cénozoïque, et les processus associés comme la subduction, la collision et l'exhumation des Alpes. L'étude moderne des transformations minéralogiques opérées sur les formations originelles par les processus métamorphiques résultants des contraintes géodynamiques, apporte un précieux complément d'information aux données strictement tectoniques , en permettant de mieux cerner l'évolution des conditions physico-chimiques caractérisant l'histoire de la formation de l'orogène.

Cette carte est plus qu'une simple distribution des faciès métamorphiques dans les Alpes, comme c'était le cas pour les cartes métamorphiques antérieures (cf. p. ex. Frey et al., 1999) qui ne prenaient pas en compte le contexte tectonique et l'évolution géodynamique de la chaîne. Les auteurs de la présente carte ont eu un objectif plus ambitieux, en voulant montrer les contrastes dans l'évolution géodynamique qui caractérisent différentes portions de l'orogène alpin. Pour ce faire, ils auraient souhaité tenir compte de l'information cinématique dérivée des données structurales et paléomagnétiques, d'une part, et de la répartition des flysch, d'autre part. Malheureusement, la distribution de ce type de données est très inégale et aurait affecté la lisibilité de la Carte. Ils ont donc préféré porter leur attention sur *le type et le degré du métamorphisme*, étant donné que ces caractéristiques du métamorphisme reflètent les processus géodynamiques dont les roches ont été l'objet. Cette nouvelle carte montre ainsi quelles sont les unités qui ont subi tel ou tel processus particulier et, de manière approximative, à quelle époque et à quelle profondeur cela s'est produit. Le choix été fait de se référer aux conditions correspondant au moment où le pic de pression et celui de température ont été atteints simultanément, ou quand un pic de température a été obtenu à des pressions plus basses après une augmentation significative de la température pendant le chemin de la décompression (zones hachurées horizontalement, dans les Alpes Centrales). Cette solution permet de voir, au premier coup d'œil, quel est le processus géodynamique qui contrôle la structure métamorphique principale : subduction pour les Alpes Occidentales ; collision pour les Alpes Centrales ; histoire plus complexe pour les Alpes Orientales qui résultent d'une histoire géodynamique et métamorphique impliquant la succession des deux processus. Ainsi, avec cette nouvelle carte on peut voir où se trouvent, dans les Alpes, les types de métamorphisme liés à la subduction, la collision, et l'exhumation.

La philosophie de la carte a été de *ne prendre en compte que l'histoire Méso-Cénozoîque des Alpes, c.à d. de l'orogenèse "alpine"*, tout le passé métamorphique antérieur étant omis. Ce qui, du coup, la rend beaucoup plus lisible par rapport aux essais cartographiques antérieurs, un peu trop chargés parce qu'intégrant, en y mettant l'accent, l'aspect polymétamorphique et/ou plurifaciès. Dans cette nouvelle édition, la carte principale ne représente que la distribution spatiale des conditions aux pics métamorphiques, *quel que soit l'âge de ces derniers.* Des indications sur l'âge de ce métamorphisme figurent sur une autre carte, placée en encart, à l'échelle du 1/2 000 000), avec une légende indiquant les deux grands types de métamorphisme : 1/ métamorphisme de subduction, à pression dominante (de 35 à 59 Ma ; 60 à 89 Ma ; 90 à 110 Ma) ; 2/ métamorphisme syntectonique et post-collision, à température dominante (de 0 à 59 Ma avec t < 300°C ; 60 à 110 Ma, t < 300° c ; et également des indications sur l'âge du refroidissement pour l'isotherme 300°C).

La légende de la carte principale liste les 15 divisions qui ont été utilisées et qui sont basées sur les différentes associations de minéraux du métamorphisme reconnus dans les roches d'origine mafique, d'une part, et pélitique, d'autre part. Les couleurs attribuées à ces –
différentes unités ont été choisies de telle sorte qu'elles puissent être regroupées en trois ensembles de teintes permettant de visualiser les trois grands contextes géodynamiques : teintes bleues à violet/pourpre pour la subduction, jaunes à vertes et rouge pour la collision continentale, et orangées pour les conditions de hautes température qui semblent liées à l'exhumation.

La carte donne, ainsi, une image relativement simple pour les *Alpes Occidentales* avec un domaine interne dominé par les hautes pressions chevauchant le domaine externe allant des schistes verts à un faible degré du métamorphisme, cette disposition découlant d'une subduction suivie d'une exhumation le long d'un chemin de décompression froid. À l'inverse, les *Alpes Centrales* montrent un environnement typique de subduction à laquelle a succédé une collision intense conduisant à un épisode de réchauffement au cours du chemin de décompression. Quant aux *Alpes orientales,* elles sont caractérisées par des reliques de subduction et des phénomènes de réchauffement dans divers édifices tectoniques ; cette complexité est le fruit de deux orogenèses successives, l'une crétacée, l'autre cénozoïque.

En conclusion, cette carte autorise une approche plus aisée de l'évolution géodynamique au cours de l'orogenèse alpine.

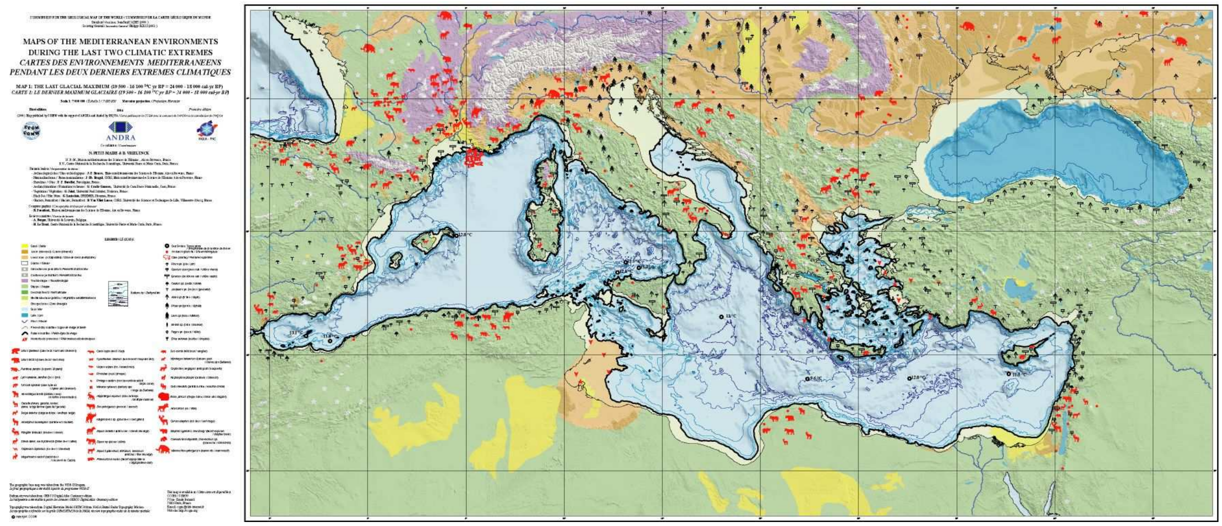
La *Carte Structurale du Métamorphisme des Alpes* a été publiée par la Commission de la Carte Géologique du Monde en août 2004 (dimensions: 119 cm x 78 cm).

Ph. Bouysse (CCGM)

Références

– Oberhänsli R. (Editor), (2004) : Explanatory Notes to the Map "Metamorphic Structure of the Alps", *Mitt. Öster. Min. Ges.*, 149 : 113-226 + un dépliant.
– Frey M., Desmons J.,& Neubauer F., (1999) : Metamorphic Map of the Alps. 1 :500 000 – *Schweiz. Mineral. Petrogr. Mitt., 79, 1.*
– Agard P. & *Lemoine M. (2003) : Visages des Alpes. Structure et évolution géodynamique, Éditions CCGM, Paris, 50 p.+ 1 CD.*

MAP OF THE MEDITERRANEAN BASIN DURING THE LAST TWO CLIMATIC EXTREMES



In the long run, the future of our climate should be heading towards a new glacial maximum due to the *natural* astronomical trend. However, the man-induced atmospheric pollution generates a rapid increase in the natural greenhouse effect on the Earth's surface.

Cooling? Warming? It happened before! Since 1995, the CLIMEX (CLIMate EXtremes) Project, designed and managed by Nicole Petit-Maire of CNRS (French National Scientific Research Organisation), presents original publications synthesizing multidisciplinary data disseminated in the worldwide scientific literature relevant to the paleogeographic (physical, biological, human) modifications induced by the last two global main climatic changes *i.e.* 1/ the **Last Glacial Maximum**: ca.20 000 – 16 000 years before Present (non-calibrated ^{14}C years) and 2/ **Holocene Optimum:** peak of the warm/wet phase of our current interglacial stage, 9 000 – 7 000 years Before Present (id.). These maps correspond to an average global temperature at Earth's surface respectively 5° C lower and 2° C higher than nowadays. During the last decade, "paleosnapshots" maps, easily available to all types of readership, have been issued for the Sahara (1993), China (1998), the World (1999), France (1999), and recently, Italy (2004). These cartographic documents were respectively sponsored by CNRS, AFCRST (French-Chinese Association for Scientific and Technical Research), CGMW, ANDRA (French National Agency for Nuclear Waste Management), and ENEA (Ente Nazionale per l'Energia e l'Ambiente).

Presently (2004), CLIMEX has released a set of two new maps displaying the *Mediterranean Basi*n, a climatic transition zone. Hence, it should be highly sensitive to the main global changes and the cartographic pictures provided here vindicate this belief. Although these pictures *cannot be taken for analogues* of forthcoming periods, whatever colder or warmer, they may reflect the modifications to be expected from the shifting atmospheric circulations and hydrological balances.

On a topographic background, four types of data have been plotted: 1) the significant geoclimatic traits: dunes, loess, glaciers, and permafrost; 2) the distribution of the dominant vegetal cover (tundra, steppe, decidual forest, and Mediterranean vegetation; 3) the location of the large mammalian fossil fauna (37 species); 4) prehistoric settlements.

These maps constitute a useful tool for the current topical debate on the effects of a few degrees difference in the Earth's climate, either if the slow natural trend (astronomical forcing) prevails towards a colder distant future or if the extant enhancement of the greenhouse effect, due to the recent boom of human activities prevails, as probable.

In addition, this map will provide prehistorians, archaeologists, and historians with an original tool for a better understanding of the fundamental cultural events which occurred during the last twenty millennia.

Nicole Petit-Maire

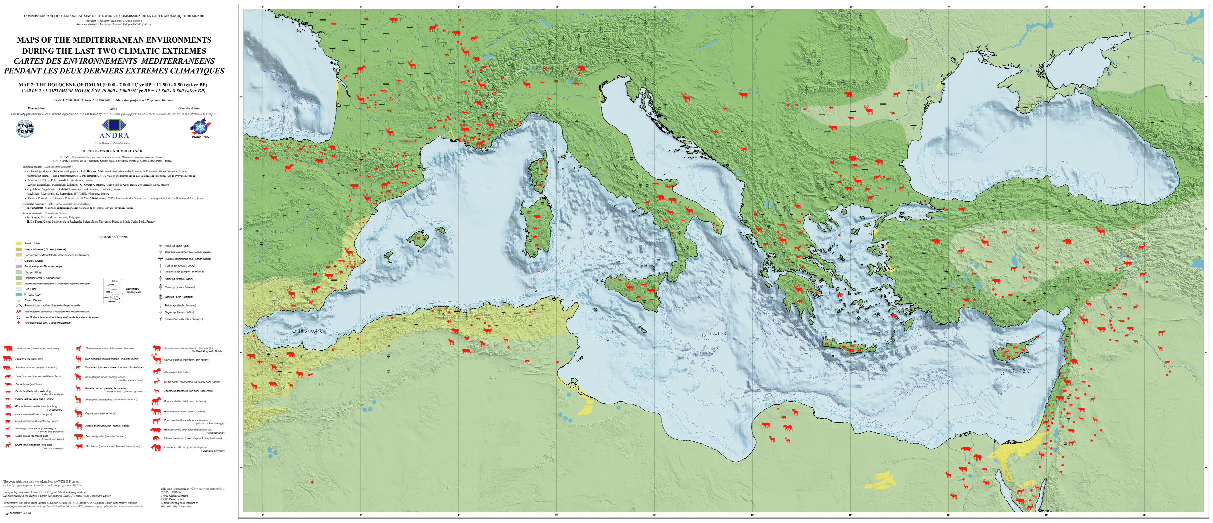
Publication of the Commission for the Geological Map of the World (CGMW) carried out with the support of ANDRA and INQUA. First edition (2004).
Set of two sheets:
1/ Last Glacial Maximum (19 500 -16 100 yr ^{14}C B.P.; 24 000 – 18 000 cal-yr B.P.)
2/ Holocene Optimum (9 000 – 7 000 yr ^{14}C B.P.; 11 500 – 8 500 cal-yr B.P.)

Mercator projection, 1: 7,000,000 at Equator.

Size: 119 cm x 54 cm each sheet. No digital version available

Price: 15 €

CARTES DU BASSIN MEDITERRANÉEN
PENDANT LES DEUX DERNIERS EXTREMES CLIMATIQUES



Notre futur climatique tend *naturellement*, à long terme, vers une nouvelle glaciation. Cependant, la pollution de l'atmosphère due aux activités humaines réchauffe rapidement la surface terrestre.

Refroidissement ? Réchauffement ? C'est déjà arrivé ! Depuis 1995, le Projet CLIMEX (Climats Extrêmes) conçu et dirigé par Nicole Petit-Maire au CNRS, propose des travaux inédits synthétisant les données multidisciplinaires, dispersées dans la littérature scientifique internationale, sur les variations paléogéographiques (physiques, biologiques, humaines) induites par les plus récents changements majeurs du climat global, c. à d. 1/ le **Dernier Maximum Glaciaire** : ca 20 000 – 16 000 ans avant nos jours (années ^{14}C non calibrées) et 2/ l'**Optimum Holocène** : pic de la phase chaude/humide de notre interglaciaire, 9 000 – 7 000 ans avant nos jours (id.). Ces cartes correspondent à une température moyenne globale à la surface de la Terre, respectivement, inférieure de 5° C et supérieure de 2° C à la moyenne actuelle. Au cours de la dernière décennie, des cartes accessibles à tous publics – véritables "paléophotographies" – ont déjà été publiées pour le Sahara (1993), la Chine (1998), le Monde (1999), la France (1999) et, tout récemment, l'Italie (2004). Ces documents ont été sponsorisés respectivement par le CNRS, l'AFCRST (Association Franco-Chinoise pour la Recherche Scientifique et Technique), la CCGM, l'ANDRA (Agence Nationale pour la gestion des Déchets Radioactifs) et l'ENEA (Ente Nazionale per l'Energia e l'Ambiente).

Aujourd'hui (2004), CLIMEX propose les cartes correspondantes du *Bassin Méditerranéen*; c'est une zone de transition climatique, elle est donc très sensible aux grands changements globaux : les images produites le confirment. Bien que ne pouvant pas être prises pour des *analogues* de futurs plus froids ou plus chauds qu'actuellement, elles reflètent certainement en partie les modifications à attendre de circulations atmosphériques et de bilans hydrologiques différents.

Sur un fond topographique donnant une image du relief, ont été reportés : 1) les phénomènes géoclimatiques significatifs : dunes, loess, glaciers, et pergélisols ; 2) la distribution des zones de végétation dominante (toundra, steppe, forêt décidue et végétation méditerranéenne) ; 3) les localisations des fossiles de grands mammifères (37 espèces différentes représentées sous forme de vignettes) ; 4) les sites préhistoriques.

Ces cartes pourront être utiles à la réflexion très actuelle sur les changements que quelques degrés de différence pourraient induire soit si l'on suit la tendance naturelle (forçage astronomique) vers un lointain futur, plus froid, soit avec un réchauffement qui est déjà déclenché, conséquence de l'explosion des activités humaines.

En outre, ces cartes devraient permettre aux préhistoriens, archéologues et historiens de mieux comprendre les faits culturels essentiels qui se sont produits au cours des derniers vingt millénaires.

Nicole Petit-Maire

Publication de la Commission de la Carte Géologique du Monde (CCGM) réalisée avec le concours de l'ANDRA et de l'INQUA. Première édition.

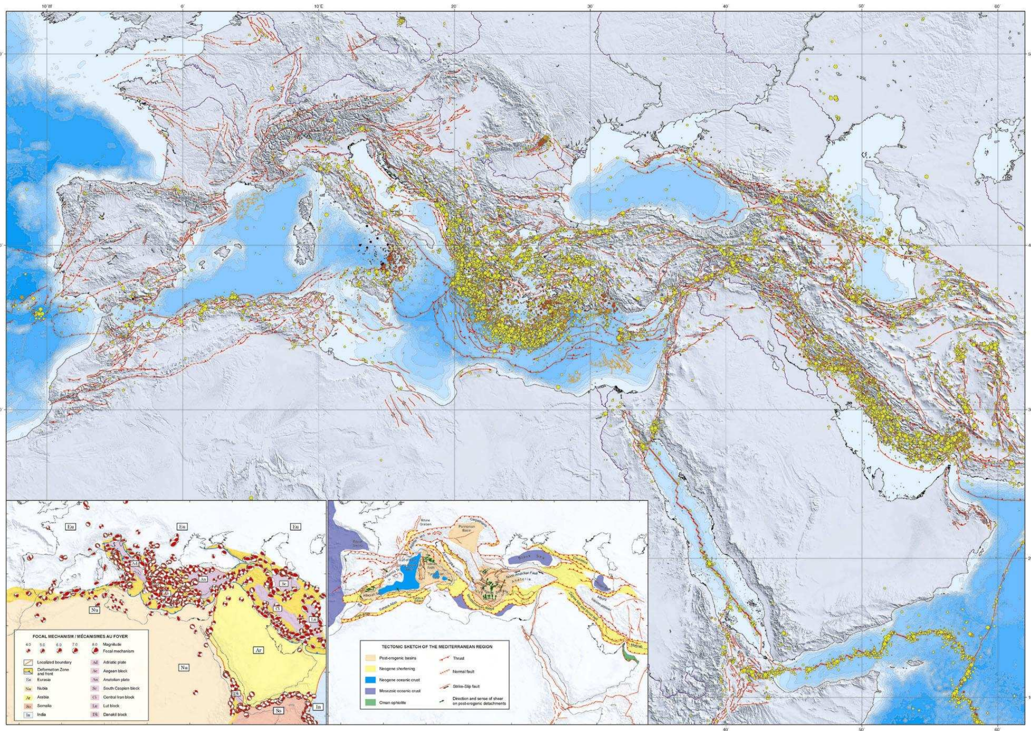
Ensemble de 2 feuilles :

1) Dernier Maximum Glaciaire (19 500 -16 100 ans ^{14}C B.P.; 24 000 – 18 000 ans cal. B.P.)
2) Optimum Holocène (9 000 – 7 000 ans ^{14}C B.P.; 11 500 – 8 500 ans cal. B.P.)

Projection Mercator, 1/7 000 000 à l'équateur.
Dimensions: 119 cm x 54 cm pour chaque feuille. Pas de version numérique disponible

Prix: 15 €

THE GEODYNAMIC MAP OF THE MEDITERRANEAN



Map 2. Seismicity & Tectonics

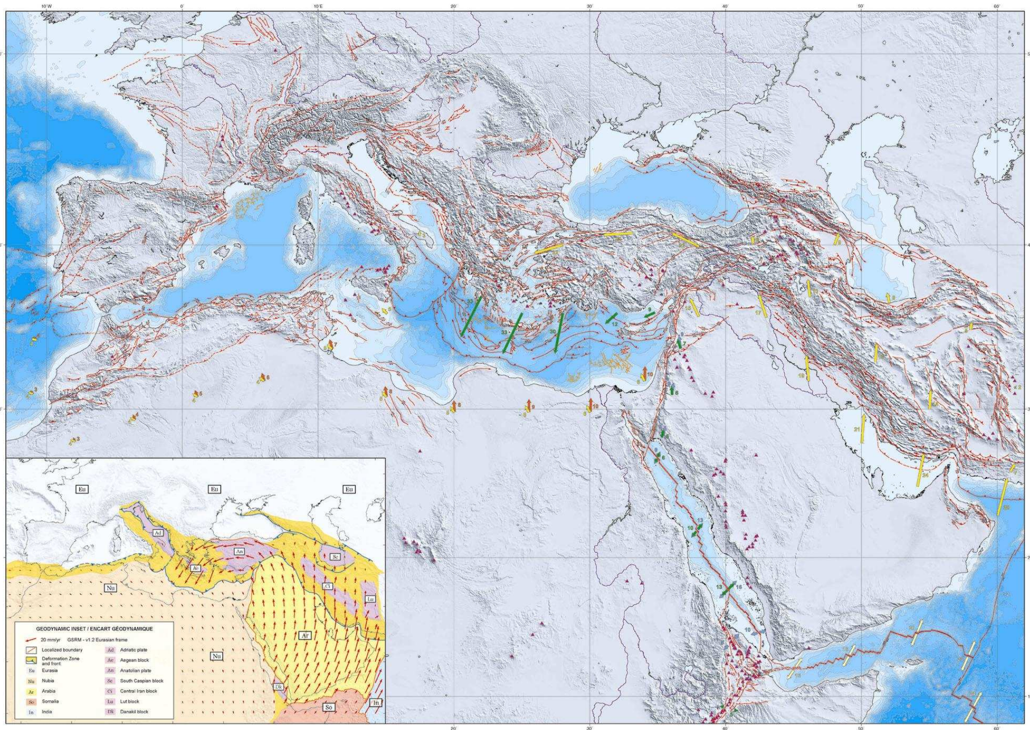
This publication is the result of a new CGMW cartographic concept. The prime purpose of the *Geodynamic map of the Mediterranean* was to produce an updated synthetic picture of the **current geodynamics** of the region, compiled from several different and dishomogeneous data sets relevant to recent tectonics, to seismicity, kinematics, and volcanism. As a matter of fact, the Mediterranean region and surrounding areas are a key collisional region where the Nubia, Arabia, Somalia, and Eurasia lithospheric plates interact. The time period selected is relatively short, from 300 000 years to Present, covering the last two glacial maxima and the intervening interglacial. Actually, it is assumed that the kinematic pattern of this period, inferred from geodetic measurements, remained stable but is nevertheless long enough for providing geological evidences of the activity of tectonic features.

On sheet 1, *Tectonics and Kinematics*, the main map displays: several types of tectonic features (faults, thrusts, …) that might have been activated or reactivated during the time lapse considered above (Late Quaternary); velocity vector of the plates' movement; some 237 eruptive centers assumed to have had volcanic activity during the last 150 000 years. The velocity vectors have been established using mainly geodetic measurements provided by the latest (2003) GSRM model. A *Geodynamic inset* summarizes the geodynamic features of the main map: well defined plate boundaries; diffuse deformation zones; minor plates (or blocks; e.g. Adriatic plate, or Danakil block); vectorial field of plate motions.

On sheet 2, *Seismicity and Tectonics*, the earthquakes are displayed on the same tectonic pattern as sheet 1. As a matter of fact, seismicity, the main cause of natural hazards in this region extending in the map from the Atlantic to the Indian Ocean and Caspian Sea, underlines the current tectonic activity. The earthquakes are plotted essentially from the International Seismological Center database and concern the period 1964-2003. Only relocated events have been considered. The epicenters have been represented using different symbols according to their magnitudes (3-4.4; 4.5-5.4; ≥ 5.5) and their focal depths (0 – 50 km; 51-100 km; 101-300 km; > 300 km). Two insets are included in this sheet, one showing the *Focal mechanisms*, the other presenting a *Tectonic sketch of the Mediterranean region* with the age of the different small oceanic basins (remnants Mesozoic basins, Neogene basins) and post-orogenic basins (e.g. Tyrrhenian basin) along with the main tectonic features.

Set of 2 sheets: 1-Tectonics and Kinematics; 2-Seismicity and Tectonics
First edition, ©CGMW, 2004
Projection: Mercator; scale: 1:13 000 000 at the Equator (ca. 1:10 000 000 at the center of the Map)
Size: 99 cm x 53 cm
Price: 15 €

CARTE GEODYNAMIQUE DE LA MEDITERRANEE



Map 1. Tectonics & Kinematics

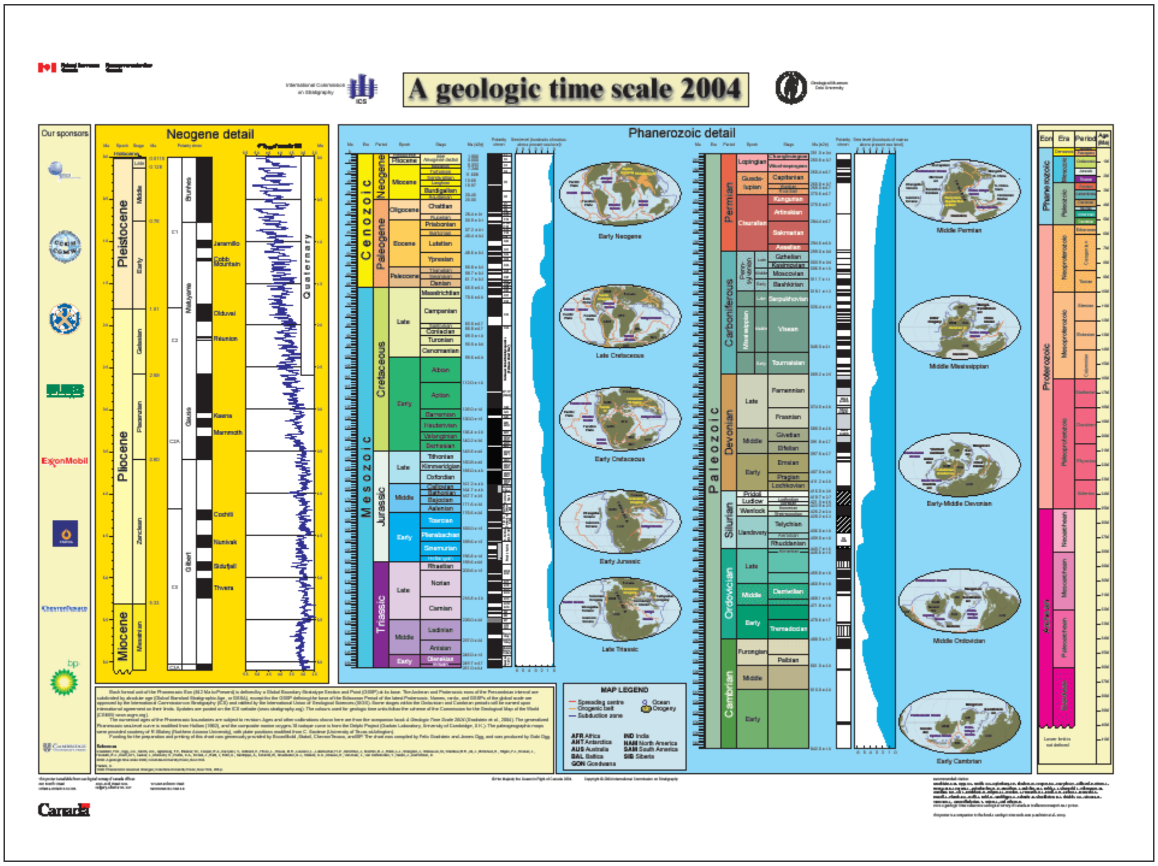
Cette publication est le résultat d'un nouveau concept cartographique mis au point à la CCGM. L'objectif premier de la *Carte géodynamique de la Méditerranée* était de produire une image synthétique moderne de la **géodynamique actuelle** de cette région, à partir de sources de données différentes et hétérogènes ressortissant à la tectonique récente, la sismicité, la cinématique et le volcanisme. Il convient de souligner que l'aire méditerranéenne et les zones environnantes correspondent à une région-clé de collision où interagissent les plaques lithosphériques Nubie, Arabie, Somalie et Eurasie. On a choisi une période de temps relativement courte, de 300 000 ans à l'Actuel, couvrant les deux derniers maximums glaciaires et l'interglaciaire Éemien. En effet, on fait l'hypothèse que les caractéristiques cinématiques, déduites des mesures géodésiques, sont restées stables pendant cette période qui est cependant suffisamment longue pour pouvoir fournir des preuves géologiques d'une activité le long des accidents tectoniques.

Sur la feuille 1, *Tectonique et Cinématique*, la carte principale montre : plusieurs types d'accidents tectoniques (failles, chevauchements, etc.) qui ont pu être activés ou réactivés pendant le laps de temps considéré ci-dessus (Quaternaire supérieur); les vecteurs de vitesse du déplacement des plaques; les quelque 237 centres éruptifs que l'on suppose avoir eu une activité volcanique au cours des derniers 150 000 ans. Les vecteurs de vitesse ont été établis principalement à partir des mesures géodésiques fournies par le dernier modèle GSRM (2003).Un *Encart Géodynamique* résume les caractéristiques géodynamiques de la carte principale : frontières de plaques bien définies; zones de déformation diffuse; plaques secondaires (ou blocs; p. ex. plaque Adriatique ou bloc Danakil); champ vectoriel de mouvement de plaques.

Sur la feuille 2, *Sismicité et Tectonique*, les séismes ont été reportés sur le même schéma tectonique que celui de la feuille 1. On rappellera que la sismicité, cause majeure des risques naturels de cette région qui sur la carte s'étend de l'Atlantique à l'océan Indien et à la Caspienne, souligne l'activité tectonique actuelle. La sélection de tremblements de terre provient principalement de bases de données du Centre International de Sismologie et concerne la période 1964-2003. Seuls les événements relocalisés ont été pris en considération. Les épicentres ont été représentés à l'aide de symboles différenciés selon la magnitude (3-4,4; 4,5-5,4; ≥ 5,5) et la profondeur du foyer (0 – 50 km; 51-100 km; 101-300 km; > 300 km). Deux encarts ont été insérés dans cette feuille; l'un montre les *Mécanismes au foyer*, l'autre l'*Esquisse tectonique de la région méditerranéenne* où sont figurés les différents petits basins océaniques (bassins fossiles mésozoïques, bassins néogènes) et post-orogéniques (p. ex. bassin Tyrrhénien) ainsi que les principales caractéristiques tectoniques.

Ensemble de 2 feuilles: 1- Tectonique et Cinématique; 2- Sismicité et Tectonique
Première édition, ©CGMW, 2004
Projection: Mercator; échelle: 1/13 000 000 à l'équateur (c-à-d. environ 1/10 000 000 au centre de la carte). Dimension: 99 cm x 53 cm
Prix: 15 €

A GEOLOGICAL TIME SCALE 2004



Like all Earth sciences disciplines, chronostratigraphy is continually evolving, and the geologic time scales must be periodically updated with numerical ages provided with an ever increasing precision.

The International Commission on Stratigraphy (ICS), affiliated to the International Union of Geological Sciences (IUGS, which every four years co-organises the International Geological Congress) is the international academic organisation in charge of establishing officially the denomination and the calibration of geological time divisions and subdivisions.

During the 32nd International Geologic Congress (IGC) held in Florence on August 2004, the ICS, sponsored by a number of organisations – among which the CGMW –, released the very last chronostratigraphic scale, four years after the publication of the one issued for the Rio de Janeiro IGC. Regarding the former edition, this new scale includes not only important revisions concerning absolute ages, but it presents an original conception which includes the following new features: 1) the space devoted to the different stages is no longer constant but proportional to their duration; 2) consequently, and for obvious reasons, it includes three built-in scales concerning: a) the entirety of geological times, b) the Phanerozoic, c) the Neogene; 3) a Phanerozoic polarity chron scale; 4) a generalized Phanerozoic sea level curve; 5) the Neogene composite marine oxygen isotopic curve; 6) a succession of 10 paleogeographic sketches indicating the position of the continental blocks from Early Cambrien up to Early Neogene.

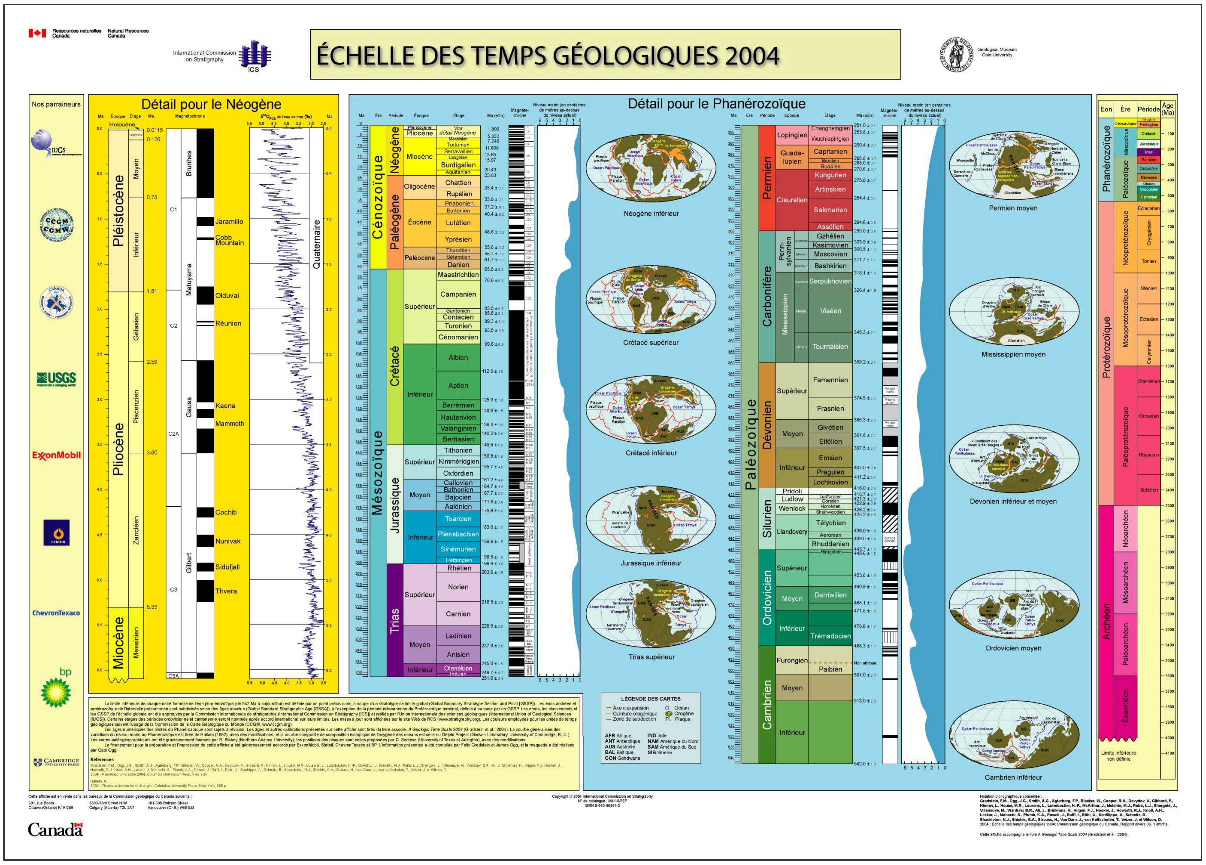
In conclusion, this is a very practical document indispensable for "setting the records straight".

It exists in two versions:

1) The French version established by the Canadian geological survey ("Natural Resources Canada")

2) English original version
Dimensions: 97cm x 68,5cm
Price: 5 €

ECHELLE DES TEMPS GEOLOGIQUES 2004



Comme toute discipline des sciences de la Terre, la chronostratigraphie ne cesse de progresser, et les échelles des temps géologiques doivent être périodiquement mises à jour, avec des âges numériques donnés avec une précision de plus en plus grande.

La Commission Internationale de Stratigraphie (ICS en anglais), dépendant de l'Union Internationale des Sciences Géologiques (IUGS, qui co-organise la tenue du Congrès Géologique International tous les quatre ans) est l'organisation académique internationale chargée de statuer officiellement sur la dénomination et le calibrage des différentes divisions et subdivisions des temps géologiques.

A l'occasion du 32^{e} Congrès Géologique International (IGC) qui s'est tenu en août 2004 à Florence, l'ICS vient de publier, avec le parrainage de nombreux organismes – dont la CCGM–, la toute dernière échelle chronostratigraphique, quatre ans après celle parue pour l'IGC de Rio de Janeiro.

Cette nouvelle échelle comporte non seulement des révisions importantes en ce qui concerne les âges absolus, par rapport à l'édition précédente, mais présente une conception inédite qui inclut les nouveautés suivantes : 1) l'espace dévolu aux différents étages n'est plus constant mais proportionnel à leur durée réelle; 2) en conséquence, et pour des raisons évidentes, elle présente trois échelles emboîtées concernant a) la totalité des temps géologiques, b) le Phanérozoïque, c) le Néogène; 3) une échelle des magnétochrones (inversions magnétiques) pour le Phanérozoïque; 4) une courbe de la variations du niveau de la mer pour le Phanérozoïque; 5) la courbe composite de la composition isotopique de l'oxygène de l'eau de mer pour le Néogène; 6) une succession de 10 schémas paléogéographiques balisant l'évolution de la disposition des masses continentales depuis le Cambrien inférieur jusqu'au Néogène inférieur.

En résumé, un document très pratique et indispensable pour remettre "les pendules à l'heure".

Existe en 2 versions :

1) Française établie par le service géologique du Canada ("Ressources naturelles du Canada")

2) Anglaise, qui constitue l'original.

Dimensions: 97 cm x 68,5 cm

Prix: 5 €

CGMW ACCOUNTS

COMPTES CCGM

2003 & 2004

GILLES GUILLAUME
EXPERT-COMPTABLE
INSCRIT AU TABLEAU DE L'ORDRE D.P.L.E.
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TÉLÉCOPIE : 01 42 24 60 44
COURRIEL: gilles.guillaume5@wanadoo.fr

1- CERTIFICATION

Je soussigné Gilles GUILLAUME, expert-comptable, certifie la sincérité des bilans et comptes recettes-dépenses de la C.C.G.M. présentés ci après, dont l'actif au 31 décembre 2003 s'élève à 397.493,47 euros.

Le 20 janvier 2004

G. GUILLAUME

YEAR 2003 FINANCIAL STATEMENT

(YEAR ENDING DECEMBER 31, 2003)

	ACCOUNT IN EUROS	ACCOUNT IN USD		*TOTAL IN EUROS*
		USD	Equivalent in EUROS(2)	
OPENING (01.01.02)(1)	***€ 42 787,50***	***$200 458,84***	***€ 178 809,29***	**€ 221 596,79**
INCOME 2003				
Membership fees(2)	61 148,62	*4 522,00*	4 033,62	65 182,24
Corporate subsidies	2 400,00		0,00	2 400,00
BRGM subsidy	15 245,00		0,00	15 245,00
IUGS subsidy		*2 500,00*	2 230,00	2 230,00
UNESCO support - map preparation		*9 000,00*	8 028,00	8 028,00
UNESCO support - map publication	7 999,42		0,00	7 999,42
Publication sales	83 200,11	*128,25*	114,40	83 314,51
Tethys & Peri-Tethys Atlases revenues	5 802,73		0,00	5 802,73
Potential bank interest (FCP)	198,36		0,00	198,36
USD account interest		*54,01*	48,18	48,18
Various refunds	7 487,85		0,00	7 487,85
TOTAL	**€ 183 482,09**	***$16 204,26***	**€ 14 454,20**	**€ 197 936,29**
EXPENSES 2003				
Salaries(4)	45 998,59			45 998,59
Projects support(5)	6 436,26	*5 504,00*	4 909,57	11 345,83
Exhibitions & international events	6 401,14			6 401,14
Meetings, missions(6)	1 070,43			1 070,43
Maps & CD printing	25 491,02			25 491,02
Advertising & bulletin printing(7)	3 330,92			3 330,92
Marketing costs	3 862,54			3 862,54
Purchase of maps & documents	879,33			879,33
Office rent, insurance, taxes, cleaning(8)	19 238,78			19 238,78
Postage, phone, fax, internet	9 437,91			9 437,91
Bureautics(9)	13 408,25			13 408,25
Office supplies & maintenance	2 601,03			2 601,03
Office equipment				0,00
VAT refunds and USD income tax				0,00
Banking fees	883,02	*103,97*	92,74	975,76
TOTAL	**€ 139 039,22**	***$5 607,97***	**€ 5 002,31**	**€ 144 041,53**
Balance 2003	**€ 44 442,87**	***$10 596,29***	**€ 9 451,89**	***€ 53 894,76***
CLOSING (31.12.03)(2)	**€ 87 230,37**	***€ 211 055,13***	**€ 188 261,18**	***€ 275 491,55***

(1) In view of the important variation of exchange rates in 2003, the amounts of the opening are calculated at the rate of 0,892 x 1 USD

(2) Increase due resumption of payments from country members (USA, Kenya, Colombia) and Russia's 3 years advanced payments

(3) The conversions of USD into Euros are calculated at the 2003 average rate of 0,892 Euros x 1 USD

(4) Assistant-secretary on a full-time basis and employer's social contributions.

(5) Financial support for maps preparation and related meetings.

(6) Includes missions of Secretariat General's board, public relations expenses

(7) Includes adversiting, catalogue and web site (maintenance)

(8) Includes 2002 last quarter cleaning invoice and increase of 6,6% in the cleaning contract.

(9) Concerns soft and hardware acquisitions, photocopier rent, maintenance and supplies for computer & photocopier

January 2004

1- CERTIFICATION

Je soussigné Gilles GUILLAUME, expert-comptable, certifie la sincérité des bilans et comptes recettes-dépenses de la C.C.G.M. présentés ci-après, dont le total des excédents au 31 décembre 2004 s'élève à 422.629,29 euros.

Le 11 février 2005 G. GUILLAUME

YEAR 2004 FINANCIAL STATEMENT

(YEAR ENDING DECEMBER 31, 2004)

	ACCOUNT IN EUROS	ACCOUNT IN USD		TOTAL IN EUROS
		USD	Equivalent in EUROS[2]	
OPENING (01.01.04)[1]	***€ 87 230,37***	***$211 055,13***	***€ 188 261,18***	**€ 275 491,55**
INCOME 2004				
Membership fees[2]	37 106,18	*1 795,00*	1 455,75	38 561,93
Corporate subsidies	1 200,00		0,00	1 200,00
BRGM subsidy	15 200,00		0,00	15 200,00
IUGS subsidy		*4 000,00*	3 244,00	3 244,00
UNESCO support - map preparation		*10 000,00*	8 110,00	8 110,00
Sponsoring from other organisations for map publications	13 000,00		0,00	13 000,00
Publication sales	105 263,68	*228,19*	185,06	105 448,74
Tethys & Peri-Tethys Atlases revenues	2 083,51		0,00	2 083,51
Potential bank interest (FCP) and saving account interest[3]	1 150,48		0,00	1 150,48
USD account interest		*23,93*	19,41	19,41
Various refunds	12 103,59		0,00	12 103,59
TOTAL	**€ 187 107,44**	***$16 047,12***	**€ 13 014,21**	**€ 200 121,65**
EXPENSES 2003				
Salaries[4] and social contributions	47 002,89			47 002,89
Projects support[5]	13 897,69		0,00	13 897,69
General Assembly, 32 IGC and participation to exhibitions	24 658,90			24 658,90
Meetings, missions[6]	295,00			295,00
Maps & CD printing	24 158,36			24 158,36
Advertising & bulletin printing[7]	569,29			569,29
Marketing costs	7 539,28			7 539,28
Purchase of maps & documents	18 954,21			18 954,21
Office rent, insurance, taxes, cleaning	15 359,62			15 359,62
Postage, phone, fax, internet	10 647,02			10 647,02
Bureautics[8]	8 262,34			8 262,34
Office supplies & maintenance	1 618,22			1 618,22
Office equipment	226,78			226,78
Banking fees	723,37	*58,98*	47,83	771,20
TOTAL	**€ 173 912,97**	***$58,98***	**€ 47,83**	**€ 173 960,80**
Balance 2004	**€ 13 194,47**	***$15 988,14***	**€ 12 966,38**	***€ 26 160,85***
CLOSING (31.12.04)[2]	**€ 100 424,84**	***€ 227 043,27***	**€ 184 132,09**	***€ 284 556,93***

(1) The amounts of the opening are calculated at the rate of 0,892 x 1 USD.

(2) The average exchange rate for 2004 is calculated at 0,811 x 1 USD.

(3) A savings account was opened in 2004 (50 150 Euros).

(4) Assistant-secretary on a full-time basis and employer's social contributions.

(5) Financial support for maps preparation and related meetings.

(6) Includes missions of Secretariat General's board, public relations expenses.

(7) Includes adversiting, catalogue and web site (maintenance).

(8) Concerns soft and hardware acquisitions, photocopier rent, maintenance and supplies for computer & photocopier.

January 2005

ANNEX

Résumés of new CGMW Bureau Members

Curricula vitae des nouveaux Membres du Bureau

Kristine Eva Charlotte ASCH

Address:	Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Stilleweg 2, 30655 Hannover, Germany
Telephone:	(++49) +511 643 3324
Fax Number:	(++49) +511 643 3782
E-mail address:	k.asch@bgr.de

Nationality:	German
Date of Birth:	18 May 1963
Profession:	Geologist
Current Position:	Project Manager, BGR
Years in BGR:	9

Education and qualifications

2001 – 2002 Doctor of Natural Sciences, Freie Universität, Berlin
Thesis title: The 1:5 Million International Geological Map of Europe and Adjacent Areas: Development and Implementation of a Geological GIS
Referees: Prof. em. V. Jacobshagen, Prof. F. List

1981 – 1989 Diploma in geology/palaeontology, Freie Universität, Berlin
Thesis title: Mineraltrennung dreier Plutonite aus Nord-Portugal zur Bestimmung der Verteilungskoeffizienten von Spurenelementen (*Mineral Separation of Three Plutonites of Northern Portugal to Determine the Distribution Coefficients*)

Professional positions and affiliations

Chairperson elect of the Commission for the Management and Application of Geoscience Information, International Union of the Geological Sciences.

Chairperson of the Working Group on Digital Map Standards, Commission for the Geological map of the World.

Member of the Contact Group on European Standards for Digital Geological Cartography and Computer Modelling, Forum of European Geological Surveys.

Steering Group member, Geological Data Model International Collaboration (DMIC, an international collaboration initiative on a global geological data model).

Fellow, Deutsche Geologische Gesellschaft (*German Geological Society*).

Chairperson of Working Group on Environmental GIS 1996-1998, Gesellschaft für Umweltgeowissenschaften *(Society for Environmental Geosciences*); member GUG Advisory Board 1997-2000.

Coordinator, Thematic Maps Topic Network, EuroGeoSurveys, 1998 – 1999.

Co-Chairperson, Young Scientists group in BGR and NLFB (Niedersächsisches Landesamt für Bodenforschung, *Geological Survey of Lower Saxony)*, 1995-2001.

Career history

1995 - present Manager of the International Geological Map of Europe and Adjacent Areas Project, BGR, Hannover: Responsibilities include: overall design of map and GIS content and the project methodology and procedures; coordination of 48 contributing countries; establishing map and database standards and dictionaries; liaising with expert geoscientists and the CGMW Bureau, leading the BGR team; documenting and publicising the project through papers, presentations and media.

Co-author of the 1:2,75 million scale Geological Map of Germany for the German National Atlas. Organiser of two international workshops “The Geological Map: Masterpiece or Anachronism?” and “Recent and Future Developments in the Application of Geoscience

	GIS" (EuroGeoSurveys/ESRI) in Hannover. GIS-geological consultancy assignments in China and Namibia. Editor, GIS in Geosciences and the Environment (Springer, Heidelberg, 1999)
1991-1994	Geologist, Geological Survey of Lower Saxony, Hannover, investigating distribution of potential barrier rocks for the building of municipal landfills in Lower Saxony: co-author of 14 maps
1990-1991	Contractor for various consultancy firms on environmental geology in Berlin
1986-1988	Scientific assistant, sample preparation of magmatic rocks for XRF analysis, Freie Universität, Berlin

Selected publications

Scientific papers

Asch, K. (2003): The 1 : 5 Million International Geological Map of Europe and Adjacent Areas: Development and Implementation of a GIS-enabled Concept; Geologisches Jahrbuch; SA 3, BGR, Hannover (ed.); Schweitzerbart (Stuttgart), 190 p., 45 fig., 46 tab.

Asch, K., Lahner, L. & Zitzmann, A.(2003): Die Geologie von Deutschland - Ein Flickenteppich. Deutscher Nationalatlas (*The Geology of Germany: A Patchwork Carpet. German National Atlas*).- IKT (Leipzig), 3 p., 1 map.

Jackson, I. & Asch, K. (2002): The Status of Digital Mapping in Europe: The result of a census of the digital mapping coverage, approaches and standards of 29 European Geological Survey organisations in the year 2000. Computers and Geosciences, Pergamon (Ottawa) 783-788; 10 fig.

Asch, K. (2001): Under Construction: The Geological GIS of the 1 : 5 000 000 International Geological Map of Europe and Adjacent Areas. Episodes (Beijing), 24/3; 201-204.

Asch, K. & Jackson, I. (2001): No Pain, No Gain. The Reality of Initiating and Managing Three European Geological Information Projects. Episodes (Beijing); 24/; 32-40.

Asch, K. (1999): GIS-gestützte Standortfindung für Siedlungsabfalldeponien (*GIS-aided Siting for Municipal Landfills*). - In: Asch, K. (ed.): GIS in Geowissenschaften und Umwelt (*GIS in Geosciences and the Environment*).- Heidelberg (Springer-Verlag), 65-73, 2 fig.

Asch, K. (1997): Internationale geologische Karte von Europa 1 : 5 000 000 - Neuauflage und GIS (*International Geological Map of Europe 1 : 5 000 000: New Edition and GIS*); Z. angew. Geol. (Hannover) 43/4: 231-233; 3 fig.

Asch, K. (1997): Siedlungsabfalldeponien - Standortsuche mit Hilfe von Geographischen Informationssystemen (*Municipal Landfills: Siting with Aid of Geographic Information Systems*).-Z. angew. Geol. (Hannover), 43/1: 44 - 49; 5 fig.

Siebert, H. &. Asch, K. (1996): Geowissenschaftliche Untersuchungen bei Standortsuche und Umweltverträglichkeitsprüfung (UVP) für Siedlungsabfalldeponien (*Geoscientific Investigations for the Siting and Environmental Impact Assessment of Municipal Landfills*); AbfallwirtschaftFakten 3; NLfB, NLÖ; (Hannover/Hildesheim). 8 p., 1 tab.

Dörhöfer, G., Asch, K. & Siebert, H. (1993): Die Standortsuche für Deponien - Anforderungen und Umsetzungen *(Siting for Municipal Landfills – Requirements and Applications)*.- In: Akademie Für Raumforschung und Landesplanung (eds.): Aspekte einer raum- und umweltverträglichen Abfallentsorgung (*Aspects of a Spatially and Environmentally Compatible Waste Disposal)* (Hannover), 387 - 417, 12 fig., 2 tab.

Dörhöfer, G., Asch, K. & Siebert, H. (1991): Verbreitung potentieller Barrieregesteine für die Anlage von Siedlungsabfalldeponien in Niedersachsen *(Distribution of Potential Barrier Rocks for the Building of Municipal Landfills)*.- NLfB (Hannover), 104 p., 25 fig., 4 tab., 14 maps
scale 1 : 200.000.

Editor

Asch, K. (ed.) (1999): GIS in Geowissenschaften und Umwelt *(GIS in Geosciences and the Environment)*.- Springer-Verlag (Heidelberg), 73 p.

Asch, K. (ed.)((1999): Die geowissenschaftliche Karte: Graphisches Meisterwerk oder Anachronismus *(The Geoscientific Map: Masterpiece or Anachronism)*; 1-day Workshop at BGR, Hannover; abstract volume; BGR (Hannover).

Technical Guidelines

Asch, K. &. Troppenhagen, H.-G. (1998): 1 : 5 Million International Geological Map of Europe and Adjacent Areas - Guide for Use of the Data Input Mask.- BGR (Hannover), 9 p., 8 fig.

Asch, K. (1997): 1 : 5 Million International Geological Map of Europe and Adjacent Areas: Guidelines for the Preparation of Draft Maps.- BGR (Hannover), 12 p., 5 fig., 4 tab.

Asch, K. (1997): Geographische Informationssysteme.- In: Altlastenhandbuch des Landes Niedersachsen: Wissenschaftlich-technische Grundlagen der Erkundung (*Geographic Information Systems.- In: Handbook for Hazardous Waste Deposits: Scientific-Technical Principles*). NLÖ and NLfB as LAG Altlasten; Springer-Verlag (Heidelberg), 308 - 314, 2 fig.

Abstracts

Asch, K. (in print): The Digital Geological Map and Standardisation: Consistency as the last refuge of the unimaginative.- Proceedings to the NATO Advanced Research Workshop 980147 - Poland 2003; Kluwer Academic Publishers (Dordrecht), 5 p., 2 fig.

Asch, K., Barckhausen, U., Chamot-Rooke, N., Mascle, J., Mauffret, A. & Woodside, J. (2004): Developing a Coherent Structural Approach to the Pre-Quaternary Geology of the European Off-Shore Domain for the 1 : 5 Million International Geological Map of Europe And Adjacent Areas.- Conference Web Site and CD ROM of the 1st General Assembly of the European Geosciences Union, (Nice), 1p.

Asch, K. (2003): Maps, Geologists and the Impact of IT: Is there a Need for Digital Geological Standards? In: Proceedings Volume 1, 4th European Congress on Regional Geoscientific Cartography and Information Systems.- Servizio Geologico, Sismico e dei Suoli Regione Emilia-Romagna (ed.) (Bologna), 3 - 5.

Asch, K. (2003): Applications for the Pan-European Geological GIS of the IGME 5000: Identification of areas across Europe potentially at risk from geohazards. In: Proceedings Volume 2, 4th European Congress on Regional Geoscientific Cartography and Information Systems.- Servizio Geologico, Sismico e dei Suoli Regione Emilia-Romagna (ed.) (Bologna), 1 p.

Giles, J. & Asch, K. (2002): The Rocky Road to Taxonomy Standards.- Oil Information Technology Journal, The Data Room (Sèvres), 1 p.

Asch, K (2001): Vom Zeichenstift zum Datenmanagement: Das Geo-Informationssystem der Geologischen Karte von Europa 1 : 5 000 000 (*From Drawing-Pen to Data Management: The Geo Information System of the Geological Map of Europe 1 : 5 000 000*). In: BUZIN, R. & WINTGES, T. (eds): Kartographie 2001 - Multidisziplinär und multidimensional.- Wichmann (Heidelberg), 9-21

Asch, K. (2001): The IGME 5000: A Means to Pan-European Geological Standards (Or just another local and transient convention?)".- Conference Web Site and CD ROM of the Annual Meeting of the International Association of Mathematical Geologists (IAMG), 7 p.

Asch, K. 1999): Geological Information for Tomorrow's Europe: ein (Umwelt-) geowissenschaftliches Informationssystem für das Europa von morgen.-In: Härtling, J. W., Huch, M, & Matschullat, J (eds.): Umwelt 2000 - Geowissenschafter für die Gesellschaft.- Schriftenreihe der DGG 9: 10 (Hannover), 1 p.

Asch, K. (1998): The Monitoring und Management of Geoscientific Environment and Hazard Information - The Role of GIS in Data Management and Decision Support; Abstract Vol. No. 5; Workshop on New Round Survey of Land and Resources in China.- Ministry for Land and Resources (ed.) (Beijing). 45 p.

Asch, K. (1997): The Development of a New Small Scale Geological Map of Europe as a GIS. In: . Hauska, H. (ed.): Proceedings of the 6th Scandinavian Research Conference on GIS; Centre for Geoinformatics (Stockholm). 149-155, 2 fig., 2 tab.

Asch, K. (1997): The New 1 : 5 Million Geological Map of Europe: Printed Map and GIS. In: Institut Cartogràfic de Catalunya (ed.): Proceedings - Second Congress on Regional Geological Cartography (Barcelona).

Asch, K. & Haertlé, T. (1993): The Use of a GeoInformationsystem in the Geological Survey of Lower Saxony (NLfB) for the Siting of Municipal Landfills. - In: Poster Session Volume, International Conference in Application of GIS in Hydrology and Water Resources (Wien), 11p., 6 fig.

Jean-Pierre MILESI

GENERAL BACKGROUND

Nationality:	French
Date of Birth:	04/05/1950
Profession and present position:	Ore deposit geologist, Deputy Manager Mineral Resources Division
Languages:	French, English
Length of experience:	27, all with BRGM

SUMMARY OF QUALIFICATIONS AND EXPERIENCE

Dr. Milesi is an economic geologist specialized in (1) physical volcanology and Neogene volcanism, (2) the metallogeny and polymetallic mineralization of volcano-sedimentary deposits, and (3) gold mineralization (epithermal, mesothermal, and gold-bearing conglomerate).

Dr. Milesi joined BRGM after obtaining his doctorate in 1976 and since has gained extensive field experience abroad. He was project manager for regional mineral exploration programmes in Senegal and Cameroon and, as a member of BRGM's Department of Mineral Exploration since 1980 he has both directed scientific projects and undertaken numerous expertise assignments in the Arabian Peninsula, West and Central Africa, South America, Indonesia, Canada and France.

All of Dr. Milesi's scientific studies have concerned the metallogenic assessment of gold and/or massive sulphide mineralization in greenstone belts and areas of continental volcanism. In particular, Dr. Milesi's work has led to a major, ongoing, analysis of the gold potential of Early Proterozoic rocks in West Africa (in nine countries from Senegal to Ghana) and French Guiana.

In 1994, Dr. Milesi was appointed head of the Metallogeny and Geodynamics Department of the BRGM Research Division. From 1994 to 1995, he was the Minerals Sector representative within the Research Division.

Since 1999, Dr. Milesi is Deputy Manager of the BRGM Mineral Resources Division and scientific co-ordinator of research teams in the fields of metallogeny and regional geological synthesis.

In 2001, Dr. Milesi obtained a D. Sc from the University of Lyon for his outstanding work on metallogeny, especially in Africa

In 2002, he was awarded the Cross of the “Ordre National du Mérite” by the French Ministry foir Scientific Research and Technology, the highest French civilian distinction.

ACADEMIC BACKGROUND

2002	Declared eligible for a University Professor position.
2001	“Habilitation à Diriger des Recherches” (equivalent to a D. Sc.) from the University of Lyon for his outstanding work in metallogeny, especially in Africa. Thesis: "Towards the measurement of metallogenic potential" (i*n French*).
1976	Doctorat de 3ème cycle in Applied Geology (Petrography and Volcanology options) from the Dolomieu Institute, Geology and Mineralogy Laboratory, University of Grenoble. Thesis: "Dynamics of the pyroclastic flows of the eastern Cantal on the basis of those in the Alagnon valley, Massif Central" (i*n French*).
1974	Diplôme d'Etudes Approfondies (Diploma in Advanced Studies) in Applied Geology (Civil Engineering option) from the University of Grenoble
1973	Maîtrise in Applied Geology (Civil Engineering, Historical Geology, Structural Geology, Petrography, Mineralogy, Hydrogeology) from the University of Grenoble.

PROFESSIONAL EXPERIENCE

Since 1976 with BRGM

1999 to present **MINERAL RESOURCES DIVISION**

Deputy of the Division Manager, in charge of co-ordination of scientific programmes and of the Africa GIS Project.
BURKINA FASO (2003): country –wide reassessment of the metallogenic potential,target selection and identification of a new regional exploration programme for BUMIGEB, the National Geological Survey (Financing: European Development Fund)
SENEGAL (2002): for IAMGOLD, assessment of the mineral exploration programme of the Bambaji area with recommendations for the redefinition of the existing exploration programme
NAMIBIA (2002): metallogenic expertise of the Precambrian basement of the Rehoboth regular geological map for the National Geological Survey (Financing: European Development Fund)
MAURITANIA (2001-2002): metallogenic expertise of the Precambrian basement within the geological mapping programme of northern Mauritania, for the National Geological Survey (Financing: World Bank)

1994-1999 **DEPARTMENT OF METALLOGENY AND GEODYNAMICS**

Appointed head of the newly formed department within BRGM's Research Division, responsible for scientific research in fields related to BRGM's mineral exploration programmes.

1980-1994 **DEPARTMENT OF MINERAL EXPLORATION**

Senior economic geologist/metallogenist and head of scientific projects, involved in a multitude of scientific and practical assignments, many of which overlapped. Among the more important are:

1985-1989 **West Africa:** Project Manager for a scientific study into the mineralization, mainly gold, of the Early Proterozoic (Birimian) rocks of Senegal and Ghana. The project was carried out in close cooperation with the various West African geological surveys and universities. Coordinated a synthetic compilation based on numerous geological and metallogenic traverses in nine countries, with visits and multidisciplinary studies of all the known mineral deposits.

1987-1992 **South America:** Scientific Project Manager in charge of a metallogenic study of the Early Proterozoic rocks of French Guiana and Brazil.

1988-1992 **Worldwide:** Scientific Project Manager for a metallogenic study of epithermal (Au-Ag) mineralization in different countries.
1988 - Orcopampa and Shila mines in southern Peru.
1990 - Cirotan Mine and Ciawitali deposit in West Java.
1991 - Lawyers Mine in British Columbia.

1983-1985 **Morocco:** Volcanological and metallogenic study of several massive-sulphide districts, such as Jebilets.

1984-1992 **Canada:** Visits (1984) to the major gold and massive-sulphide occurrences of the Archean greenstone belts, including the Hemlo Mine and the massive-sulphide deposits in the amphibolite facies rocks around Lake Superior. Consultancy (1990) for the exploration of the Grevet massive-sulphide deposits in Quebec. Consultant (1991, 1992) for the epithermal (Au-Ag) Lawyers Mine and the shear-zone (Au, Zn) J & L Mine in British Columbia.

1983 **Oman:** Volcanological evaluation of the northern Oman Mountains, in support of a metallogenic study by J.L. Lescuyer.

1981-1983 **Saudi Arabia:** Economic geologist/metallogenist with the BRGM Mission for the Directorate General of Mineral Resources (Ministry of Petroleum and Mineral Resources). Metallogenic inventory of Cu-Pb-Zn-Au mineralization in volcano-sedimentary rocks. Study of gold-bearing prospects associated with volcanic sequences.

1980-1982 **France:** Economic geologist/metallogenist responsible for the study of volcano-sedimentary polymetallic Cu-Pb-Zn-Au-As mineralization in the French Palaeozoic. Metallogenic studies of mineral occurrences in the Monts de l'Est de Lacaune (Montagne Noire). Expert metallogenic and volcanological evaluations of mineral occurrences for the Mineral Inventory of France. In charge of specific studies of massive-sulphide deposits in Palaeozoic rocks at Chessy (Zn, Cu, Ba) near Lyons and at La Haie Claire (Au-Ag) in the Armorican Massif.

1976 to 1979 GEOLOGIST AND PROJECT MANAGER

1979 **Cameroon:** Geologist and project manager responsible for a regional exploration programme forming part of the joint BRGM-FED regional and detailed exploration of volcano-sedimentary formations, nepheline syenites, itabirites and ultrabasic rocks within a 70,000 km² area of southern Cameroon. Study of the Fe-Au-U prospects and polymetallic sulphides.

1976-1978 **Senegal:** Geologist and project manager responsible for the study of mineral occurrences in volcanic-plutonic rocks (Au at Sabodala), volcano-sedimentary and ultrabasic rocks (Cu, Ni at Gabou) and gold-bearing shear zones (Au at Mako). Application of standard mineral-exploration techniques (mapping, rock, soil and stream geochemistry, core drilling, and reconnaissance pitting and trenching).

1976 **France**: Geologist responsible for mapping and sampling mineral occurrences related to zones of propylitization in the volcanic rocks of the Cantal.

ASSOCIATIONS AND LEARNED SOCIETIES

Society of Economic Geologists

Society for Geology Applied to Mineral Deposits, member (Elected councillor from 1998 to 2001)

Geological Society of Africa

Member of the Editing Committee of African Earth Sciences (Elsevier)

PUBLICATIONS

Feybesse JL., Duguey E., Guerrot C., Billa M., Milesi J.P., Lescuyer J.L. Bouchot V., Nicol N. (2003). Gold mineralization of the Ghana Paleoproteroic active margin - Geodynamic model and the contribution of regional-scale stress modelling to multicriteria metallogenic prediction. Precambrian Research (In Press).

Feybesse J.L., Lerouge C., Guerrot C., Billa M., Diaby S. and Milési J.P. The Archean-Proterozoïc contact zone of West Africa: a long-lived (2.3-2.07 Ga) convergent zone (2003).. The contribution of metamorphic-tectonic-plutonic chronological relationships. Precambrian Research (Submitted).

Ledru P., Becker T., Wackerle R., Hutchins D., Milesi J.P., Pinna P., Schreiber U., Truffert C., Tourlière B. (2003). Crustal blocks and accretionnary process in the Southern Damara foreland (Namibia, Rehoboth region), new insights from high-resolution airborne geophysical surveys. Journal of South African Geology (Submitted).

Milesi J.P., Lerouge C., Delor C., Ledru P., Billa M., Cocherie A., Egal E., Fouillac A.M., Lahondere D., Lasserre J.L., Martel-Jantin B., Rossi Ph., Tegyey M., Thiéblemont D., Théveniaut H., Vanderhaeghe O. (2003). Gold mineralisations (Au-tourmalinites, Au-conglomerates and mesothermal lodes) : markers of geological evolution of French Guiana. Geology, metallogeny and stable isotopic constraints. Géologie de la France n° 2-3, pp. 145-178 (In Press).

Tadesse S., Milesi J.P. and Deschamps Y (2003). - Geology and Mineral Potential of Ethiopia: a note on Geology and Mineral Map of Ethiopia (including CD Rom with digital data); JAES (In Press).

Grancea L., Bailly L., Leroy J., Banks D., Marcoux E.,.Milesi J.P., Cuney M., André A.S., Istvan D., Fabre C. (2002). Fluid evolution in the Baia Mare epithermal gold/polymetallic district, Inner Carpathians, Romania. Mineralium Deposita, vol. 37, 630-647.

Marcoux E., Grancea L., Lupulescu M., Milesi J.P. (2002). Lead isotope signatures of epithermal ans porphyry-type ore deposits from the Romanian Carpathian Mountains. Mineralium Deposita, vol. 37, 173-184.

Milesi J.P., Ledru P., Marcoux E., Mougeot R., Johan V., Lerouge C., Sabate P., Bailly L., Respaut J.P., Skipwith P. (2002). The Jacobina Paleoproterozoic gold-bearing conglomerates, Bahia, Brazil: a “hydrothermal shear-reservoir” model. Ore Geology Reviews, 19, 95-136.

Greffié C., Bailly L., Milesi J.P. (2002). Supergene alteration of primary ore assemblages from low sulfidation Au-Ag epithermal deposits at Pongkor, Indonesia, and Nazareno, Peru. Economic Geology, Vol. 97, p. 561-571.

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Harsh K. Gupta

(Career highlights in brief)

General

Born on June 28, 1942, Dr Gupta had his education at the Indian School of Mines [B.Sc.(Hons), M.Sc. and A.I.S.M] and University of Roorkee (Ph.D.). He availed two years UNESCO fellowships for advanced studies at Tokyo. Dr Gupta has published over 130 research papers in International Journals, written 3 pioneering books published by Elsevier Scientific Publishing Company, Amsterdam and edited over 15 volumes. He has held senior responsible positions for the past 21 years, including Vice-Chancellor of Cochin University of Science & Technology; Director, National Geophysical Research Institute, Hyderabad; currently being Secretary to the Govt. of India looking after the Department of Ocean Development. Dr Gupta has a unique combination of rich scientific research and science administration experience. He is internationally well connected and has been a Research Scientist, Professor and Visiting Professor at a number of Universities and Institutions. He has been holding important international scientific positions and won several awards and recognitions. As the Leader of the IIIrd Indian Scientific Expedition to Antarctica, he has the distinction of establishing Indian Permanent Station at Antarctica during 1983-84 in a record time of an Antarctic summer. In the following, some details are provided:

Specialization

Earth Sciences and their application to address problems of continents and oceans, administration of educational and scientific institutions.

Research

Dr Harsh Gupta is among the most well known earth scientists in the world. During the 22nd International Union of Geology and Geophysics (IUGG) General Assembly held at Birmingham in 1999, he had the responsibility of convening a symposium on "Earthquake Precursors and Prediction". Incidentally, IUGG is the most important International Forum where around 5000 geophysicists and geodesists from all over the world meet once in four years. At the recently concluded IUGG General Assembly (2003), he convened a symposium on 'Recent Destructive Earthquakes'.

In the following, some other facts are given:

Provided the first geophysical evidence for an enormously thick crust (65-70 km) below the Tibet Plateau and Himalayan region in 1967, found to be accurate as confirmed by detailed field seismic surveys conducted in 1980s.

Over the past 40 years, through detailed studies of earthquake focal mechanism, surface wave attenuation and other related work threw much light on the geodynamic processes responsible for the high elevation of Tibet Plateau and tectonics of the Himalaya and nearby region.

Pioneered investigations of artificial reservoir induced earthquakes and developed criteria to discriminate reservoir induced earthquakes from normal earthquakes. These criteria are now internationally applied. Also developed procedures to estimate potential of occurrence of reservoir induced earthquakes at a given site. He discovered that reservoir induced earthquakes of magnitude ≥ 5 are generally preceded by a couple of M ≥ 4 earthquakes.

Completed a detailed study in 1986 of earthquake swarms and quiescence that precede major earthquakes in the northeast India region and concluded that major earthquakes are preceded by well-defined swarms and quiescence. Also made a medium term forecast of a
8± ½ magnitude earthquake to occur in area bound by 21°N and 25 ½ ° N, and 93°E and 96°E with a focal depth of 100 ± 40 km before the end of 1990. This has come true.

Completed ‘stress pattern’ for the Himalayan and the Andaman-Nicobar Region as inferred from earthquake focal mechanism.

Dr Gupta has recently carried out detailed studies of Latur earthquake, the deadliest stable continental region earthquake, and shown that fluids existing at shallow crustal depths played an important role in the genesis of Latur earthquake.

Very recently he has developed the concept of spectral magnitudes and showed its application in learning about characteristics of seismic sources using broadband recordings. One latest application has been in characterizing the nuclear explosion.

Research related with Ocean Science

Dr Harsh Gupta has been very deeply involved with investigations related to oceans. Early in his career during 1964-65 he participated in the India Ocean Expedition Programme where joint expeditions were undertaken in the Arabian Sea by the German research vessel Meteor and Indian research vessel Kistna. In 1968 he carried out very detailed investigations of regional crustal structure of the Bay of Bengal and Arabian Sea using the state-of-the-art surface wave dispersion techniques. Later, as the Director, Centre for Earth Science Studies (1982-87), Trivandrum, he pioneered efforts to generate wave atlas of the west coast of India. Detailed work on placer deposits on the west coast was also carried out.

He was the Leader of the 3rd Indian Scientific Expedition to Antarctica (1983-84), which established a permanent base for India in a record time. This station fulfilled a very urgent scientific requirement of the country.

In the recent years, at the National Geophysical Research Institute, he initiated a very detailed work on Gas Hydrates in the Exclusive Economic Zone of India. Sponsored by the Gas Authority of India Limited, a comprehensive report has been prepared under his leadership entitled “Gas Hydrate Exploration along the Continental Margins of India – Evaluation of Available Geophysical and Geological Data”. Another landmark work has been the analysis of 80,000 line km of single channel seismic data in the Indian Exclusive Economic Zone to identify locations where bottom simulating reflectors occur. This has been extremely helpful in identifying zones of gas hydrate occurrences.

One of the major requirements in Antarctica has been the setting up of a permanent seismic station as well as permanent GPS station. Under Dr Gupta’s stewardship these two major objectives were achieved during 1996-97 and 1997-98. India now boasts of one of the best state-of-the-art GPS station and a digital seismic data acquisition system in Antarctica.

Publications

SCIENTIFIC RESEARCH PAPERS

Over 130 papers in scientific journals of international repute, including 5 in Science/Nature.
(a list of publications is attached)

Books authored

(1) Gupta, H.K. and B.K. Rastogi (1976). “Dams and Earthquakes”, Elsevier Scientific Publishing Company, Amsterdam, 229 p. (Translated into Russian in 1979 and Chinese in 1980).
(2) Gupta, H.K. (1980). “Geothermal Resources: An Energy Alternative”. Elsevier Scientific Publishing Company, Amsterdam, 227 p.
(3) Gupta, H.K. (1992). “Reservoir Induced Earthquakes”, Elsevier Scientific Publishing Company, Amsterdam, 364 p.

VOLUMES EDITED

- Tectonophysics	3
- I.G.U.	1
- A.G.U.	1
- Current Science	1
- Inter Union Commission on Geodynamics	1
- Department of Ocean Development (GOI)	1
- Physics of the Earth and Planetary Interior	1
- Geological Society of India	3
- Pure & Applied Geophysics	1
- INSA Proceedings	2

Positions held

Currently, Dr Gupta is Secretary to the Government of India, looking after the Department of Ocean Development. Among the important positions held earlier include Director, Centre for Earth Science Studies, Trivandrum (1982-87); Vice-Chancellor, Cochin University of Science & Technology, Cochin (1987-90); Adviser, Department of Science and Technology (DST), Government of India, New Delhi (1990-92); and Director, National Geophysical Research Institute, Hyderabad (1992-2001). Earlier, he was a Research Scientist at the University of Texas at Dallas (1972-77) and has been an Adjunct Professor during 1977 through 2001.

Institution Building

Dr Gupta has been involved from a very young age in senior administrative positions of institution building. He built Centre for Earth Science Studies at Trivandrum from a scratch. This included development of a whole campus in a short time of two years (1984-86). He also had the responsibility of building Indian Scientific Station in Antarctica which he did with distinction and completed all the tasks in a record time of one Antarctic summer (1983-84). In his capacity as Vice-Chancellor of Cochin University of Science and Technology (at the age of 45 years he was the youngest Vice-Chancellor in the country), among several things, he created DRDO – Cochin University of Science & Technology, Computer Centre equipped with the then latest available computers for joint research projects. He also hosted the Science Congress in January 1990, the first Science Congress in Kerala, which, people still remember as one of the best conducted Science Congress meetings. At DST, during his stay of two years (1990-92) he initiated many new programmes including consolidating DST inputs on IGBP projects.

During 1992-2001, Dr Gupta was the Director at the National Geophysical Research Institute (NGRI), Hyderabad. NGRI has risen to the position of one of the top few CSIR laboratories. From a meager rupees one crore external cash flow during 1993-94, it has grown to 11 crores during 1996-97 and the same level is maintained since then. NGRI won the prestigious Technology Prize for Business Development and Technology Marketing during 1997. At NGRI, Dr Gupta has revolutionized application of earth sciences to the basic needs of the country. This has included delineation of Mesozoic sediments (which could be petroliferous) under Deccan Trap cover, and a new chapter has been opened in looking for Gas Hydrates in offshore region of India. NGRI has also significantly contributed in water resource finding, rain water harvesting and water pollution related studies as well as ways and means of assessing and safeguarding against earthquake hazards.

INTERNATIONAL ASSOCIATIONS

Dr Gupta has been very active internationally. He is currently a Bureau Member of the International Union of Geodesy and Geophysics (IUGG) and Councillor of the International Union of Geological Sciences (IUGS). Earlier he has been the Chairman of the Steering Committee of Global Seismic Hazard Assessment Programme (a UN initiative); Chairman of IASPEI/UNESCO/ICL Working Group on Seismology and Related Sciences in Africa, as well as Bureau Member and Chairman of several Committees of the International Lithosphere

Programme. He was the Founder President of Asian Seismological Commission. He has convened several international symposia at IUGG, IASPEI and IGU Assemblies. During January 1998, he convened a Chapman Conference on "Stable Continental Region Earthquakes" at NGRI, Hyderabad, this being the first Chapman Conference ever held in Asia.

Science Communication

Dr. Gupta has been extensively involved with science communication and popularization. He has given numerous talks on Earthquakes and what can be done about it, at different forums in India and abroad. He was the Chairman of the Steering Committee of the recently concluded Global Seismic Hazards Assessment Programme, one of the programmes initiated by U.N. for International Decade of Natural Disaster Reduction (IDNDR), where over 500 scientists worked globally from 1992 to 2001 to prepare, for the first time, a global map of Earthquake Hazard. He has convened several interesting workshops and symposiums which produced excellent volumes. In 1999, he convened, on behalf of Indian National Science Academy (INSA), a unique symposium on "Deccan Heritage" with specialists on Deccan Bio-diversity, Earth Sciences and Culture which resulted in a volume "Deccan Heritage" published by University Press. He convened a symposium on Water Resources and their Management at INSA (March 12, 2001), which was attended by a large scientific community. Recently, Dr. Gupta convened a Seminar on 'Key Issues in Ocean Sciences in 21st Century' at INSA on 9th March, 2002.

Special Assignments

Dr Gupta has been visiting Professor at University of Paris Sud, Paris, France, University of Texas at Dallas, USA and at the University of Hamburg, Germany. He has been also a visiting Scientist at US Geological Survey and Adviser/Consultant to UNESCO, IAEA and Commonwealth Science Council on several occasions.

HONOURS AND AWARDS

Fellow	Indian National Science Academy
Fellow	Third World Academy of Sciences, Italy
Fellow	National Academy of Sciences, India.

Dr Gupta has won several awards. To mention a few:

1977	Indian School of Mines Golden Jubilee "Outstanding Alumni" Award
1978	Krishna Gold Medal of the Indian Geophysical Union
1983	Shanti Swarup Bhatnagar Prize for Science & Technology in Earth Sciences
1985	USSR Academy of Sciences "100 Years of International Geophysics", Memorial Medal
1989	The first "Dr Anil Kumar Ganguli" Memorial Oration Award, BARC, Bombay
1991	National Mineral Award, Government of India
1993	The Department of Atomic Energy, Government of India "C.V. Raman Lectureship".
1995	Indian Science Congress Association Jubilee Lecture
1995	CSIR Technology Prize for Business Development and Technology Marketing
1997-98	Ninth Professor K.P. Rode Memorial Lecture of the Indian Science Congress Association
1998	Second Outstanding performance Award by the 11th International Kharazmi Festival of Iranian Research Organization for Science and Technology, Teheran, Iran
1998	Indian Geophysical Union Decennial Award
1999	Federation of Indian Chambers of Commerce and Industry, New Delhi, Award for Physical Sciences,
1999	IGU Millennium Award
2000	Indian Society of Applied Geochemists Millennium Award
2001	Vikram Sarabhai Memorial Lecture, Department of Space
2001	First Dr. H.N. Siddiquie Memorial Lecture, Indian Geophysical Union
2002	22nd G.P. Chatterjee Memorial Award, Indian Science Congress Association
2003	Jawaharlal Nehru Visiting Fellowship 2003, Indian National Science Academy
2003	The 4th Prof. C. Karunakaran Endowment Lecture
2003	Bruun Memorial Lecture, 22nd session of the Assembly of Int. Oceanographic Commission, Paris.
2003	National Mineral Award for Excellence-2002

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EDUCATION:

1982, BSc. of geology, Changchun College of Geology (now merged into the Jilin University)

1986, MSc. of economic geology, Changchun College Of Geology

1994, Ph.D of economic geology, Changchun University Of Earth Sciences (working as a teaching staff while completing the Ph.D program).

WORKING EXPERIENCE:

3/1982-8/1983,	Teaching assistant at Dept. of Geology, Changchun College of Geology, in the subject of remote sensing geology and structural geology.
8/1983-8/1986,	During the Msc program, studied the Neoproterozoic granites and associated tin mineralisation in western Sichuan, China.
8/1986-8/1989,	Teaching staff at the Dept. of Geology, Changchun College of Geology, teaching courses in the area of economic geology. Taking part in the National Project 305 on mineral exploration in the Proterozoic metamorphic tarrane, Xinjiang, Northwest China (305-75-20v). Promoted as a lecturer in 1987.
9/1989-9/1990	Academic visitor to Camborne School of Mines, UK, working on the fluid inclusion and geochemistry of the hydrothermal deposits in Cornwall, Southwestern England.
9/1990-10/1995	Teaching staff in Changchun University of Earth Sciences, working on the geochemistry and origin of the Plaeoproterozoic borate deposits in Liaoning and Jilin province, Northeastern China. Also jointed the research on the exploration of Silver and mangnese deposits in Shanxi Province, China. Promoted as associate professor in 1992, Professor in 1994.
10/1995-5/1997	Post doctorate at the department of geology, University Of Bristol, UK, working on boron and trace element geochemistry of borate and copper deposits in China (sponsored by the British Royal Society).
5/1997-7/1999,	Administration staff at the Science division of Geological Survey of the Ministry of Geology and Mineral Resources, as assistant chief geologist from Jan. 1998.
7/1999-12/2001	Northern division chief of the Dept. of Mineral Resource Assessment, China Geological Survey.

12/2001-present Director of Department Science, Technology and International Cooperation, China Geological Survey

PUBLICATIONS:

Peng, Q.M., Feng, B.Z., Liu, J.D. and Zhou, R., 1993, Geology of the Proterozoic boron deposits in Liaoning, Northestern China. Resource Geology (Japan), Special Issue No.15:343-350.

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Peng, Q.M. and Xu, H., 1994, The discovery of native ruthenium in Nuanquanzi and Tuling-Shihu gold deposits: implications for source of gold. 《Geochemistry》V.13: 55-60.

Wang, A.J. and Peng, Q.M., 1994, Origin of the foliations in the sodium charnockitic gneisses in eastern Hebei province, China. Jurnel of Sutheastern Asian Earth Sciences, V.10: 205-215.

Peng, Q.M. and Palmer, M.R., 1995, The Paleoproterozoic boron deposits in Liaoning, China: a metamorphosed evaporite. Precambrian Research, V.72:185-194.

Jiang, S.Y., Palmer, M.R., Peng, Q.M. and Yang, J.H., 1997, Isotopic geochemistry of the deposit at Houxianyu, Liaoning, China. Chemical Geology.

Peng, Q.M. and Palmer, M.R., 1997, Involvement of evaporite in metal mineralisations in the North China Platform. Mineral Deposits, Proceedings of the 4th SGA.

Wang, A.J., Peng,Q.M. and Palmer, M.R., 1998, Salt Dome-Controlled Sulfide Precipitation of Paleoproterozoic Fe-Cu Sulfide Deposits, Eastern Liaoning, Northeastern China. Econimic Geology, 93, 1-14.

Peng, Q.M., Palmer, M.R. and Lu, J.W., 1998, Geology and geochemistry of the Paleoproterozoic borate deposits in Liaoning-Jilin, northeastern China: evidence of metaevaporites. Hydrobiologia, V. 381: 51-57.

Peng, Q.M. and Palmer, M.R., 1999, Borate deposits in Liaoning and Jilin provinces, NE China: a guide to identifying Paleoproterozoic collision settings, Continental Dynamics, V.4: 15-22.

Peng, Q.M. and Palmer, M.R., 2002, The Paleoproterozoic Mg And Mg-Fe Borate Deposits of Liaoning and Jilin Provinces, Northeast China. Economic Geology, 97, 93-108.

OLEG V. PETROV

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DATE AND PLACE OF BIRTH:	20 August 1954, Rostov-on-Don, Russia
NATIONALITY:	Russian
MARITAL STATUS:	married with three children
CURRENT POSITIONS:	Director General, Karpinsky All-Russia Geological Research Institute (VSEGEI) Chairman, Main Editorial Board for Geological Mapping of the Ministry of Natural Resources of the Russian Federation Chairman of the VSEGEI Academic Council

SHORT PROFESSIONAL BIOGRAPHY

Director General of Karpinsky All-Russia Geological Research Institute (VSEGEI) of the Ministry of Natural Resources of the Russian Federation, a leading Russian organization in regional geology and metallogenesis that comprises 30 research departments and employs over 700 personnel. The institute carries out a series of federal programmes, including those on compilation of 1:200,000 to 1:2,500,000 State Geological Maps, long-term estimation of Russia's mineral resources potential and fundamental description of tectonic and geodynamic development of Russian territories. Dr. Petrov personally initiated the international project to compile GIS Atlas for Central Asia and Eurasia. Under his direction the institute underwent a major technical modernization that has, among other achievements, resulted in creation of the world-class Centre of Isotopic Research.
Prior to 1998, as director general of Central Arctic Geological Expedition in Norilsk, Dr. Petrov supervised implementation of a vast programme of geological survey, geophysical and prospecting surveys in the Norilsk area, the Taimyr Peninsula and the Severnaya Zemlya Archipelago. His work contributed to discovery of the Taimyr-Severnaya Zemlya gold province.

MAJOR RESEARCH INTERESTS

- geological mapping of Russia's territories at 1:200,000 to 1:1,000,000 scales; compilation of 1:2,500,000 and 1:5,000,000-scale composite and general geological and geophysical maps. Chairman of the Main Editorial Board for Geological Mapping of the Russian Ministry of Natural Resources.
- geodynamics of the Earth's interior and related metallogenesis. Plume tectonics mechanisms and their influence on the evolution of sedimentary basins of the Siberian and East European platforms. Over 20 related publications.
- forecasting and evaluation of new nickel-bearing regions of the northern Siberian platform. Fundamental regularities of crystallization in natural sulphide melts and origin of copper-nickel ore. Over 25 related publications.

EDUCATION

MSc	Geological Engineering (Geological Survey, Prospecting and Exploration of Mineral Deposits), Rostov State University, 1976
PhD	Mineralogy and Geology, Leningrad Mining Institute, 1985
MBA	State and Municipal Management, Russian Academy of Civil Service under the patronage of the President of the Russian Federation, 1999

DISSERTATION

"Structural Features of the Norilsk and Talnakh Ore Fields Flank Zones Relating in the Light of Their Economic Evaluation"
Scientific supervisor: Professor Dr. Anatoly V. Tarasov

EMPLOYMENT

1998-Present Director General, Karpinsky Russian Geological Research Institute
1993-1998 Director, Central Arctic Geological Expedition, Norilsk
1986-1993 Geologist, later Chief Geologist, Central Arctic Geological Expedition, Norilsk
1982-1986 Principal Engineer, Copper-Nickel Deposits Department, VNIIOkeangeologia, Norilsk
1977-1982 Senior Engineer, later Principal Engineer, Sevmorgeo Research and Development Expedition, Norilsk
1975-1977 Geologist, Norilsk Industrial Complex Geological Prospecting Expedition

FIELD EXPERIENCE

1979-1990 Field surveys in Central Arctic Siberian platform areas (Taimyr Peninsula, Dolgano-Nenetsk autonomous region, etc.)

GEOLOGICAL MAPPING SKILLS

1979-1998 1:200,000 to 1:1,000,000 geological maps of the Taimyr Peninsula, Severnaya Zemlya Archipelago, Norilsk area, etc.

OTHER RESEARCH-RELATED POSITIONS

Deputy editor-in-chief, *Regional Geology and Metallogenesis* journal (published by VSEGEI)
Initiator and major coordinator of the international project *Atlas of Geological Maps for the Central Asia and Adjacent Areas*, member of the Main Editorial Board of the Atlas

HONOURS

Honorary Title: Honourable Geologist of the Russian Federation, 2002

SELECTED PUBLICATIONS

Complete list of publications includes over 60 items.

Petrov O.V. (ed.) 1:15,000,000-scale Geological Map of the World. IN Regional'naya Geologiya i Metallogeniya,vol. 11, 2000. Pp.92-94.

Petrov O.V. (ed.) State Geological Map of Russia and Adjacent Water Areas at 1:2,500,000 scale.VSEGEI: St. Petersburg. 2004.

Petrov O.V. (ed.) Anomalous Magnetic Field of Russia and Adjacent Areas at 1:500,000 scale. VSEGEI: St. Petersburg. 2004.

Petrov O.V. (ed.) Gravimetric Map of Russia at 1:500,000 scale. VSEGEI: St. Petersburg. 2004.

Petrov O.V. (ed.) Dummy of 1:2,500,000-scale Geological Map as Part of the *Atlas of Geological maps for Central Asia and Adjacent Areas*. VSEGEI: St. Petersburg. 2004.

Tarasov A.V., Petrov O.V. "Towards the problem of scientific perfection of research criteria in untapped rich copper-nickel deposits." IN Poiski i prognozirovaniye sul'fidnykh medno-nikelevykh mestorozhdenii/Research and forecasting of sulfide copper-nickel deposits. Leningrad, 1982. Pp. 5-20 [in Russian].

Morozov A. F., Petrov O. V., Burde A. I.. "The Present Status and the Strategy of Comprehensive Regional Geological Studies and Works in the 21 Century" IN Regional'naya Geologiya i Metallogeniya, 11, 5-12, 2000. [in Russian, abstract in English].

Petrov O.V., Kostyuchenko S.L. "Deep Sedimentary Basins of Siberia as a Result of the Impact of Smaller Mantle Plumes on the Earth's lithosphere IN Regional'naya Geologiya i Metallogeniya, 15, 58-74, 2002. [in Russian, abstract in English].

Petrov O. V., Kostyuchenko S. L.. "Plume Tectonics in the Evolution of Sedimentary Depressions in the East European Platform IN Regional'naya Geologiya i Metallogeniya, 16, 5-22, 2002. [in Russian, abstract in English].

Petrov O.V. (ed). Geology and Mineral Deposits of Russia, vols.2,3. – 2000, 2002. Pp.477 [in Russian].

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DATE AND PLACE OF BIRTH:	26 May 1952, Frunze Kirgizia (now Bishkek Kyrgyzstan)
NATIONALITY:	Russian
MARITAL STATUS:	married with two children
CURRENT POSITIONS:	Head of Department of Legends for Russian State Geological Maps, Karpinsky Russian Geological Research Institute (VSEGEI), St.Petersburg

EDUCATION

PhD Minerology and Geology, Institute of Geology and Geophysics of the Russian Academy of Sciences, Novosibirsk, 1990
Dissertation title "Petrogeochemical typification of North-West Altay granitoids"

MSc Geological Exploration Management, Kazakhstan Polytechnical Institute, Alma-Ata, 1986
Final Project Title "Implementing Self-Financing and Quantitative Methods of Data Quality Assessment in Geological Survey"

MSc Geological Engineering, Kharkov State University (Ukraine), 1974
Final Project Titles: "Geological, Petrographic and Mineralogical Criteria of Formation of Muscovite-Bearing Kola Peninsula Pegmatites";
"Taxonomy and Phylogeny of Jurassic Brachiopods of the Crimea, the Carpathian Mountains and the Caucasus"

EMPLOYMENT

2000-Present	Head of Department of Legends for Russian State Geological Maps, VSEGEI, St.Petersburg
1990-2000	Principle geologist and head of Geological Department, West-Siberian geological expedition, Novokuznetsk
1986-1989	Head of Edigan geological exploration division, West-Siberian geologicalexpedition, Novokuznetsk
1976-1986	Geologist, later senior geologist, West-Siberian geological expedition, Novokuznetsk
1974-1976	Geologist, Kuzbass coal-exploration division, Procop'yevsk, Kemerovo region

RESEARCH INTERESTS

- geological mapping, carthography, regional geology, tectonics, metallogeny of the western part of Central Asian Folded Belt;
- more than 50 scientific publications on geological correlation of sedimentary formations, magmatic and metamorphic complexes, tectonics and development of the Altay-Sayan region and problems of State geological mapping, and development of regional and federal GIS

FIELD WORKS

1974-1999 Field works in the Altay-Sayan Region

GEOLOGICAL MAPPING EXPERIENCE

Shokal'sky S.P. et al. Atlas of the Lithologic- paleogeographical, structural, palinspastic and geoenvironmental maps of Central Eurasia. Scientific Research Institute of Natural Resources YUGGEO: Republic of Kazakhstan. 2002. 37 maps, 26 pp.

RESEARCH-RELATED POSITIONS

National:

Editor-in-Chief of the Altay series of sheets for the 1:200 000-scale State Geological Map
Editor-in-Chief of the M-45 sheet for the State Geological Map
Member of the Bureau of the Research and Editorial Council of the Russian Ministry of Natural Resources
Member of the Editorial Board of the *Regional Geology and Metallogeny/Regional'naya Geologiya I Metallogeniya* journal
Member of the Main Editorial Board for Geological Mapping of the Russian Ministry of Natural Resources
Member of the Regional Petrography Section of the Petrographic Council

International:

Head (since 2004) of the Russian part of the Chinese-Russian Kazakhstan-Mongolian-Korean Project (2003-2006)

SELECTED PUBLICATIONS

- Vladimirov A.G., Shokal'sky S.P., Ponomareva A.P. About riftogenic-strike-slip fault nature of Late Paleozoic – Early Mesosoic Altay granitoids //Reports of RAS, 1996, т.350, No. 1.C.83-86 [in Russian, English].
- Vladimirov A.G., Shokal'sky S.P., Ponomareva A.P. Khalilov V.A., Kostitsyn Ju.A., Ponomarchuk V.A., Rudnev S.N., Vystavnoy S.A., Kruk N.N., Titov A.V. Late Paleozoic – Early Mesosoic Altay granitoid magmatism // Geology and geophysics, 1997, No. 4. P. 715-729 [in Russian, English].
- Shokal'sky S.P., Kotel'nikov E.I., and Metsner D.B., Serial legends of NGM-200 based on computer technologies as a base of long-lived geological-information systems (exemplified by the Altai series of NGM-200 sheets) //Regional'naya Geologiya i Metallogeniya*,* 1999, 44-67, 1999 [in Russian, resume in English].
- Shokal'sky S.P., Babin G.A., Vladimirov A.G., Borisov S.M. //Correlation of igneous and metamorphic complexes of the western Altay-Sayan folded area, 188 pp., Izd-vo SO RAN. "Geo", Novosibisrk. 2000 [in Russian].
- Shokal'sky S.P., Rucheikova L.D., Strel'nikov S.I., Tikhomirov I.N.. Geological mapping and formational analysis: state of the art, problems, and prospects of integration. Russian Geology and Geophysics. vol. 44, No. 12, pp. 1391-1407, 2003 [in Russian, English].

Chris Pigram

Bibliographic Notes

Dr. Pigram trained as a geologist (a BSc (Hons) UNSW, a PhD in marine geoscience from ANU) and has over 25 years experience in a wide range of geological research and mapping. He has been a senior research manager in Geoscience Australia (GA) since 1993 and has managed GA's marine and petroleum geoscience and minerals exploration and national geological program. Dr. Pigram has worked in Southeast Asia and the West Pacific as ell extensively in Australia. He has authored or co-authored over 70 publications covering minerals, petroleum, basin analysis and marine geoscience.

Dr. Pigram was part of a working group that developed Australia's Marine Science and Technology Plan and is currently serving on an Australian Academy of Earth Sciences Committee for the development of a strategic plan for the Earth Sciences. He is a former member of the Australian Academy of Sciences, Solid Earth Sciences Committee.

He is past Chairman of the Australian Committee for the Ocean Drilling Program and was the PACRIM Consortium ODP Council Member from 1996-1998.

He is a member of the Geological Society of Australia, the American Association of Petroleum Geologists and the Petroleum Exploration Society of Australia.

He is currently Chief of the Minerals and Geohazards Division in Geoscience Australia.

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PROFESSIONAL POSITION

-Research Coordinator, National Institute of Advanced Industrial Science and Technology (AIST) (2003 to present) -Director-General, Geological Survey of Japan, AIST (2003 to present)

PROFESSIONAL SERVICE

-Advisors of Committees on Examination of Reactor Safety and Examination of Nuclear Fuel Safety, Nuclear Safety Commission of Japan -Member of Policy committee, Headquarters of Earthquake Research Promotion of Japan

Education

Ph.D. (Geology), Hiroshima University, 1996

M.A. (Geology), Hiroshima University, 1976

B.A. (Geology), Hiroshima University, 1974

Area of Expertise

Structural Geology, Active Tectonics, Paleoseismology

Research Interests

Active tectonics and crustal deformation of Island arcs and seismic hazard reduction

Membership of Academic Society

-Tokyo Geographical Society -Geological Society of Japan, -Geological Society of America -Seismological Society of Japan -Seismological Society of America -Japan Association for Quaternary Research -American Geophysical Union -Japan Society of Engineering Geology

MAJOR PUBLICATIONS

MAPS

Kiyohide Mizuno, Akira Sangawa and Eikichi Tsukuda, 1994, Strip map of the Median Tectonic Line active fault system in Kinki, Geological Survey of Japan.

Eikichi Tsukuda et al, 1993, Strip map of the Atera fault system, Geological Survey of Japan

Haruo Yamazaki, Yuichi Sugiyama and Eikichi Tsukuda, 1984, 1:500,000 Neotectonic map of Kagoshima, Geological Survey of Japan

Eikichi Tsukuda et al, 1985, 1:500,000 Neotectonic map of Okayama, Geological Survey of Japan

Eikichi Tsukuda et al, 1982, 1:500,000 Neotectonic map of Kochi, Geological Survey of Japan

RESEARCH PAPERS

Honglin He and Eikichi Tsukuda 2003 Recent progresses of Active fault Research in China. Journal of Geography, 112(3) 480-520.

Eikichi Tsukuda, 2002, Rupturing history of active faults during the last 1000 years in the central Japan. *Seismoltectonics in Convergent Plate Boundary,* Terra Scientific Pub., 209-218.

Eikichi Tsukuda, 2001, Newly established Active Fault Research Center will endeavor to become the national center for active faults in Japan. Journal of Geography, 110(6), 808-815.

Ryu Ohtani, Naoji Koizumi, Norio Matsumoto, and Eikichi Tsukuda, 2000, Preliminary results from permanent GPS array by the Geological Survey of Japan in conjunction with groundwater-level observations. Earth Planets Space, 52, 663-668.

Naoji Koizumi, Eikichi Tsukuda, et al, 1999, Preseismic changes in groundwater level and volumetric strain associated with earthquake swarms off the east coast of the Izu Peninsula, Japan. Geophy. Res. Let., 26, 23, 3509-3512.

Kiyohide Mizuno, Eikichi Tsukuda, et al., 1999, Subsurface geology of the Wakayama Plain, southwestern Japan based n the deep boring survey. Jour. Geol. Soc. Japan, 105, 3, 235-238.

Takashi Nakata, Kunihiko Shimazaki, Yasuhiro Suzuki, Eikichi Tsukuda, 1998, Fault branching a nd directivity of rupturing propagation. Journal of Geography, 107(4), 512-518.

Eikichi Tsukuda, 1996, Segmentation and its related geologic structures of the Median Tectonic Line active fault system. Tectonics and Metamorphisum (the Hara volume), SOUBUN, 250-257.

Eikichi Tsukuda, 1993, Is the Central Kyushu really rifting north to south ? Memoirs of the Geological Sosiety of Japan, No.41, 149-161.

Eikichi Tsukuda, 1992, Active Tectonics of Southwest Japan arc controlled by the westward translation of forearc sliver. Memoirs of the Geol. Soc. Japan, No.40, 235-250.

Eikichi Tsukuda, 1991, Geometrical Bariiers on faults and their rupturing processes. Journal of Geography, 100, 417-428.

Eikichi Tsukuda, 1991, Geometrical Barriers on faults and their rupturing processes. Journal of Geography, 100, 417-428.

MARC MUNSCHY

Born in June 13, 1957, Colmar, France
Married, 3 children

Professional address:
Ecole et Observatoire des Sciences de la Terre
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ACADEMIC BACKGROUND

1975-1978 Advanced mathematics, specialization in Biology, Reims.
1978-1981 Geophysical Engineering at the Institut de Physique du Globe de Strasbourg, licence and maîtrise in Earth Sciences. Engineer diploma obtained in Novembre 1981.
1982-1983 Diploma in advanced studies (DEA) in Inner Geophysics and Geochemistry. Dissertation in September 1983.
1983-1987 Thesis of Doctorat from the Université Louis Pasteur, Strasbourg I. Dissertation in February 1987.
1994 "Habilitation à diriger des recherches" (equivalent to a D. Sc) from the Université Louis Pasteur, Strasbourg I. Dissertation in December 1994.
National service: Volunteer for technical support. Head of the permanent magnetic observatory of Port Alfred, Crozet Archipelago, TAAF, from December 1981 to December 1982.

PROFESSIONAL EXPERIENCE AND POSITIONS HELD

1987-1996 Assistant Physicist at the Ecole et Observatoire des Sciences de la Terre.
1996- Physicist at Ecole et Observatoire des Sciences de la Terre.
1997-2004 Head of the Research team on "Rifts and ridges" - UMR 7516.
2001- Academic director of the Earth and Univers Sciences studies of the Diploma of General Universitary Studies (DEUG) on Sciences and Technology at the Université Louis Pasteur, Strasbourg I.

FIELDS OF RESEARCH
Oceanic accretion in ridge axes (multibeam, gravimetry and magnetism), Indian and South Pacific oceans.
Ocean structure and evolution. Geophysical synthesis (bathymetry, gravimetry, magnetism, seismicity) for the Indian and South Pacific oceans, paleographic reconstructions.
Structure and evolution of the Kerguelen plateau. Interpretation and synthesis of bathymetric, seismic, gravimetric and magnetic data.
Magnetic and aeromagnetic cartography. Methodology and instrument development. Application to the study of active faults and archeology. 38 rank A publications, 25 rank B publications and 86 communications since 1985.

TEACHING AND TRAINING EXPERIENCE

50 to 100 hours of conducted practice per year since 1989.
Lectures on potential methods, plate tectonics and geophysics for DEUG students.
Direction or co-direction of 10 thesis and 10 DEA memoirs.

SERVICE

Filing and data base building on marine and seismic geophysics.

REFERENCES

PUBLICATIONS A

1) ***Mendel, V., Munschy, M., Carton, H. et Sauter, D., 2004.*** Modmag, a Matlab program for modeling marine magnetic anomalies**.** *Submitted to Computers and Geosciences.*

2) **Rotstein, Y. Edel, J. B., Boulanger, D., Gabriel, G., Schaming, M. and Munschy, M.,** Anatomy and Quaternary tectonics of the Upper Rhine graben: Insight from a new compilation of gravity data . *Submitted to Geology.*

3) **Bernard A., Munschy M., Rotstein Y., and Sauter D**. Refined spreading history at the Southwest Indian Ridge for the last 92 Ma, with the aid of satellite gravity data*. Geophys. J. Int., Soumis.*

4) **Sauter D., Carton H., Mendel V., Munschy M., Rommevaux-Jestin C., Schott J.J. and Whitechurch H**., 2004. Ridge segmentation and the magnetic structure of the Southwest Indian Ridge (49°15'-51°15'E and 54°30'-56°30'E): implications for magmatic processes at ultra-slow spreading centers. *Geochem. Geophys. Geosyst,* 5, Q05K08, doi : 10.1029/2003GC000581, .

5) **Rotstein, Y., Munschy, M. et Bernard A., 2001.** The Kerguelen Province revisited : Additional constraints on the early developments of the Southeast Indian Ocean. *Mar. Geophys. Res*., vol. 22, pp. 81-100.

6) **Bernard, A. and Munschy, M., 2000.** Le bassin des Mascareignes et le bassin de Laxmi (océan Indien occidental) se sont-ils formés à l'axe d'un même centre d'expansion. *C. R. Acad. Sci. Paris*, vol.330, pp. 777-783.

7) **Mendel, V., Sauter, D., Patriat, P. and Munschy, M., 2000.** Relationship of the Central Indian Ridge segmentation with the evolution of the Rodrigues Triple Junction for the past 8 Ma. *J. Geophys. Res,* vol. 105, pp. 16,563-16,575

8) **Westphal, M. and Munschy M., 1999.** Variations en dents de scie du champ magnétique terrestre non confirmées par les variations du champ magnétique sur les dorsales. *C. R. Acad. Sci. Paris, 329, 565-571.*

9) **Fretzdorff, S., Stoffers, P., Devey, C. W. and Munschy, M., 1998.** Structure and morphology of submarine volcanism in the hotspot region around Réunion Island, western Indian Ocean. *Mar .Geol. vol.148, pp. 39-53.*

10) **Miles, P. R., Munschy, M. and Ségoufin, J., 1998.** Structure and early evolution of the Arabian Sea and East Somali Basin. Geophys. J. Int., vol.134, pp. 876-888.

11) **Munschy, M., 1998.** La zone de Diamantine témoin de la séparation de l'Australie et de l'Antarctique : arguments géophysiques. *C. R. Acad. Sci., Paris,* vol.327, pp. 533-540.

12) **Patriat P., D. Sauter, M. Munschy and L. M. Parson, 1997.** A survey of the SWIR axis between Atlantis II FZ and the Indian Ocean triple junction: regional setting and large scale segmentation. *Mar. Geophys. Res.,* vol.19, pp. 457-480.

13) **Sauter, D., Mendel, V., Rommevaux-Jestin, C., Patriat, Ph. and Munschy, M., 1997.** Propagation ofthe Southwest Indian Ridge at the Rodrigues Triple Junction. *Mar. Geophys. Res.,* vol.19, pp.553-567.

14) **Munschy, M., Antoine, C. et Gachon, A., 1996.** La croûte océanique de la région des Tuamotu, océan Pacifique central. *Comptes Rendus de l'Académie des Sciences, vol.323, pp. 941-948.*

15) **Sauter, D., Nafziger, J. M., Whitechurch, H. et Munschy, M., 1996.** Segmentation and morphotectonic variations of the Central Indian Ridge (21°10'S - 22°25'S). *J. Geophys. Res., vol.101, pp. 20233-20256.*

16) **Munschy, M., Fritsch, B., Rotstein, Y., and Schlich, R., 1994.** Tectonique extensive sur le plateau de Kerguelen. *Mém. Soc. Géol Fr. vol.166, pp. 99-108.*

17) **Schlich, R., Angoulvant, M.P., Fritsch, B., Munschy, M., et Schaming, M., 1994.** Structure and tectonic history of the Kerguelen Plateau. ***In: Hydrocarbon and Petroleum Geology of France, Mascle, A., ed., Special Publication of the European Association of Petroleum Geoscientists, Springer Verlag, Berlin, n°4, pp. 424-426.***

18) **Chamot-Rooke, N., Jestin, F., de Voogd, B., and the PHEDRE Working Group, 1993.** Intraplate shortening in the Central Indian Ocean determined from a 2100-km-long north- south deep seismic reflection profile. *Geology, vol.21, pp. 1043-1046.*

19) **Munschy, M., Rotstein, Y., Schlich, R. and Coffin, M.F., 1993.** Structure and tectonic setting of the 77°E and 75°E grabens, Kerguelen Plateau (South Indian Ocean). *J. Geophys. Res., vol.98, pp. 6367-6382*.

20) **Royer, J. Y., Sclater, J. G., Sandwell, D. T., Cande, S. C., Schlich, R., Munschy, M., Dyment, J., Fisher, R. L., Muller, R. D., Coffin, M. F., Patriat, P., and Bergh, H. W., 1993. Indian Ocean plate reconstructions since the Late Jurassic.** *In: Duncan, R. A., Rea, D. K., Kidd, R. B., von Rad, U. and Weissel, J. K., Synthesis of results from scientific drilling in the Indian Ocean, Geophys. Monograph. Ser., AGU, Washington D. C., 70:*471-476

21) **Fritsch, B., Schlich, R., Munschy, M., Fezga, F. and Coffin, M.F., 1992.** Evolution of the Southern Kerguelen Plateau deduced from seismic stratigraphic studies and drilling at Sites 748 and 750. *In Wise, S. W., Jr., Schlich, R., et al., 1992, Proc. ODP, Sci. Results, 120: College Station, TX (Ocean Drilling Program), pp. 895-906.*

22) **Fritsch, B., Munschy M. and Fezga F., 1992.** Analysis of noise on digital sonic log data at Leg 120 sites. Derived synthetic seismogram and correlation with MCS data at Site 747. *In Wise, S. W., Jr., Schlich, R., et al., 1992, Proc. ODP, Sci. Results, 120: College Station, TX (Ocean Drilling Program), pp. 907-916.*

23) **Munschy, M., Dyment, J., Boulanger, M.O., Boulanger, D., Tissot, J.D., Schlich, R., Rotstein, Y. and Coffin, M.F., 1992.** Breakup and seafloor spreading between the Kerguelen Plateau-Labuan Basin and the Broken Ridge-Diamantina Zone. *In Wise, S. W., Jr., Schlich, R., et al., 1992, Proc. ODP, Sci. Results, 120: College Station, TX (Ocean Drilling Program), pp. 931-944.*

24) **Munschy, M., Fritsch, B., Schlich, R., Fezga, F., Rotstein, Y. and Coffin, M.F., 1992.** Structure and evolution of the Central Kerguelen Plateau deduced from seismic stratigraphic studies and drilling at Site 747. *In Wise, S. W., Jr., Schlich, R., et al., 1992, Proc. ODP, Sci. Results, 120: College Station, TX (Ocean Drilling Program), pp. 881-893.*

25) **Rotstein, Y., Schlich, R., Munschy, M. and Coffin, M.F., 1992.** Structure and tectonic history of the Southern Kerguelen Plateau (Indian Ocean) deduced from seismic reflection data. *Tectonics, vol.11, pp. 1332-1347.*

26) **Rotstein, Y., Munschy, M., Schlich, R. and Hill, P.J., 1991.** Structure and early history of the Labuan Basin, South Indian Ocean. *J. Geophys. Res., vol.96, pp. 3887-3904*.

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