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Metallogeny and the evolution of the Australian continent: linkage between mineralisation and tectonic history

David L Huston

Geoscience Australia, GO Box 378, Canberra, ACT 2601 Australia (David.Huston@ga.gov.au)

Introduction

As part of the 10th SGA Biennial meeting in Townsville, Australia, the Organising Committee is offering a series of field trips to examine the geology and setting of important mineral provinces in Australia, New Zealand and Papua New Guinea. The purpose of this short article is to provide an overview of the metallogeny of Australia, which is considered within the framework of the geological evolution of the Australian continent.

Evolution of the Australian continent

Broadly, the Australian continent grew from west to east, with Archean rocks present mostly in the west, Proterozoic rocks mainly in the centre, and Paleozoic to Mesozoic rocks in the east (Fig. 1). Myers et al. (1996) recognised that Archean and Proterozoic Australia can be divided into three major cratons: the West Australian Craton (WAC), the North Australian Craton (NAC) and the South Australian Craton (SAC). Many of the Archean and Proterozoic deposits in Australia are related to the internal growth of these cratons and their eventual amalgamation, whereas most of the deposits in eastern Australia are related to Paleozoic to Mesozoic accretion to form the Tasman Orogen. This discussion does not consider deposits younger than the Jurassic, which include sandstone-hosted U and (paleo-)placer heavy mineral sand deposits, as they formed largely after the Australian continent amalgamated.

3500-1900 Ma: Growth and amalgamation of the Yilgarn and Pilbara Cratons

The WAC consists of the Archean Pilbara and Yilgarn Cratons, which are separated by Paleoproterozoic terranes (Fig. 1). Amalgamation of these terranes to form the WAC was completed with the 2005-1960 Ma Glenburgh Orogeny, at which time the Yilgarn Craton accreted onto the already amalgamated Pilbara-Glenburgh block (Müller et al., 2005).

The Pilbara Craton contains two entities, the older granite-greenstone North Pilbara Terrane and the overlying Hamersley Basin. Metallogenically, these entities are quite different, with the North Pilbara Terrane containing a large variety of small deposits, whereas the Hamersley Basin contains a very restricted range of giant deposits. The North Pilbara Terrane, which evolved from

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SGA booth at the XIII Latin American Geological Congress, Lima, Peru
29 September–3 October 2008

Fernando Tornos, SGA Vice-President

f.tornos@igme.es

The XIII Congreso Latinoamericano de Geología and the XIV Congreso Peruano de Geología, organized by the Sociedad Geológica del Perú, were held at the Universidad Pontificia del Perú, Lima, last 29th September – 3rd October 2008. The organizing committee, in order to make the meeting as international as possible, invited SGA along with the Society of Economic Geologists and the Society of Exploration Geophysicists to sponsor some activities and actively participate in the meeting. Some months before, Eugenio Ferrari (regional VP of SGA and vicepresident of the Organizing Committee), presented to the SGA Council an ambitious program of collaboration. This is the first time that SGA is officially invited to actively collaborate in a large meeting in South America and the council decided that was an unique opportunity for expanding our presence in that continent. It is worth to note that this area is the one where we have fewer members, a feature more due to the lack of information than any other factors. In fact, in previous activities cosponsored such as the Latin American Course in Metallogeny we felt that people knew our journal but not the Society.

The meeting has included a wide variety of pre- and post-meeting courses (mostly related with ore deposits and exploration) and field trips to some large deposits in Peru including Yanacocha, Iscaycruz, Ucchuchaqua, Raura, and Morococha.

The SGA collaboration included the organization of several short curses, a symposium and a plenary lecture. The short courses were held by Gregor Borg (Unconventional Zinc deposits – Lessons to learn from supergene metallogenesis), Massimo Chiaradia (Applications of radiogenic isotopes in metallogenesis with special emphasis in the Andes) and Fernando Tornos (Massive sulphides and the relationships with volcanic rocks). While the two former ones were one-day courses, the latter included also two days of field work in two of the most relevant VMS deposits in Perú. Massive sulphides in Peru are not so well known as in other places but they represent a significant portion of the mining wealth of the country and are actively explored. Major deposits include Cerro Lindo or Maria Teresa - Colquisiri, Perubar, Tambo Grande and other several small prospects. Currently only the first two ones are mined but there is active exploration around them. In both Cerro Lindo and María Teresa, we were introduced to the geology of the mines by Ings. Alejandro Trujillo (MILPO) and Edgar Pichardo (Minera Colquisiri) and had an underground visit and a look at a complete section by drillcore inspection. This was a unique chance of looking at the structures in volcanic rocks and the relationships between massive sulphides and volcanic rocks.

The SGA symposium was included in the main session within the full meeting. There were three parallel sessions with more than 1500 attendants. About two thirds were interested in ore deposits and mining so the session was organized in a large sports pavilion. The SGA symposium, chaired by Eugenio Ferrari and Massimo Chiaradia, was entitled "New Ore Deposit Types in Latinamerica: from ore showings to industrial concentrations" and incorporated with other sessions entitled "The Economic Geology of Pb-Zn-Ag Deposits" (sponsored by SEG), "Active mineral deposits" and "Exploration Projects". The session was an excellent opportunity to present SGA to the audience. Our collaboration with the technical session finished with a plenary lecture entitled "The genesis of IOCG-like deposits: Lessons from the geology and geochemistry of the Andes and Iberia" by Fernando Tornos.

The SGA booth was one of the many stands of the meeting, which included a whole range of mining and service companies, consulting, academic institutions, and societies. The SGA booth was heavily visited and even the "spanglish" of Gregor Borg helped to convince some people to join the society. In the end, we had 23 student applications and 22 full member applications, a number that probably has duplicated our membership in Latinamerica. However, the major goal was to make our society known to a large number of people.

We are grateful to the volunteers that supported our booth (mainly Auri Morro) and to the Organizing Committee of the Meeting, especially Pepo Arce and Silvia Rosas, for helping to promote SGA in Latinamerica.

APPLICATIONS to SGA for meeting sponsorship must be submitted to Jan Pasava, SGA Executive Secretary, on appropriate forms available at the SGA home page on Internet: www.e-sga.org

Other requests will be not considered.

Your suggestions and ideas for any topic of interest to SGA are welcome!
They can be addressed to any Council member or to

Dr. Jan Pašava
SGA Executive Secretary

Czech Geological Survey
Klárov 131/3
CZ-118 21 Prague 1
Czech Republic

Tel.: +420 2 5108 5506
Fax: +420 2 518 18 748
e-mail: jan.pasava@geology.cz

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EDITOR
Massimo Chiaradia
Department of Mineralogy
University of Geneva
Geneva
SWITZERLAND

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SGA NEWS - MAILBOX
Dr. Massimo Chiaradia
Department of Mineralogy
University of Geneva
Rue des Maraîchers 13
CH-1205 Geneva
Fax: +41 22 379 32 10
e-mail: editor-sga-news@e-sga.org

Massimo Chiaradia (left), Gregor Borg (middle) and Urs Schaltegger (right) setting up the SGA booth.

Fernando Tornos in front of the SGA booth explaining the benefits of becoming SGA member to two students

Massimo Chiaradia (left) and Gregor Borg (middle) recruiting succesfully two new members.

CALL FOR CANDIDATES FOR SGA 2009 ELECTION

Names of suggested candidates for various SGA positions should be provided to

the Chair of the Nomination Committee

Prof. Dr. D. Groves

dgroves@cyllene.uwa.edu.au

by February 28, 2009.

News from the Prague Student Chapter

Aneta Štastná

Member SGA student chapter, Charles University, Prague

In the late autumn 2008 the SGA Student Chapter in Prague took part in an interesting three-days fieldtrip dedicated to the Alpine geology in Switzerland. The meeting and fieldtrip were held by students from the ETH Zürich on 14-16th November, 2008.

The first day we met our colleagues from the ETH Zürich, who introduced the Department of Earth Sciences to the members of our SGA Student Chapter. We learnt about the ETH organisation, infrastructure including their work and activities, and saw some of the wide variety of laboratory equipment. We also enjoyed the local food and the main sights of Zürich.

The second day of the joint field trip of Prague and Zürich students was dedicated to the extensive Grimsel Pass excursion. This high mountain pass (2165 m asl) is located between the valley of the Rhone River in the canton of Valais and the Haslital (upper valley of the Aar river) in the canton of Bern in the southernmost part of Switzerland. The main rock in the area is the crystalline Aar massif formed by the Old Crystalline (crystalline schists, gneisses, amphibolites) and granite of Variscan age. We visited the unique hydropower plant with a sophisticated network system where we participated in a detailed tour well lead by the guide. Part of the excursion was also a beautiful cluster of crystals in Grimsel granodiorite caves which were found during the construction of a tunnel at about 100 km. The main species were quartz in excellent crystals and large quantity also, ranging from clear to very dark smoky and in a few cases also amethyst. Even fluid inclusions were noticeable in some clear quartz crystals. Besides quartz other well-developed crystals of e.g. fluorite, calcite and chlorite occur there too. The famous alpine clefts and the minerals in granites were created about 12 to 18 million years ago when the Alps were formed under low P-T conditions at approximately 2.8 kbars and 420°C. The hydrothermal processes were clearly seen on the cave surface where the bleached granite indicated the mineral alteration of biotite into chlorite.

The last day we visited the former coal mine in Horgen-Käpfnach near Zürich. After the instructional historic film and the mining exhibition in the museum we examined the underground that meant an amazing 1.5 km rail ride with the electric mine train through the low mining tunnel. Although Käpfnach was the biggest coal mine in Switzerland, this coal mine was actually very small (80 km of tunnels in the area of 1.4 km2) and produced the young brown coal of poor quality. This coal contained water, sulphur and other contaminants. The horizontal layer of the 16 million years old coal in between sandstones, marls and conglomerates was only 20-40 cm thick. As a matter of fact, local mining was active and revived only during the world wars between 1784 and 1947 when the value of the coal rose. Local sediments originate from the Alps from where they were transported by extensive rivers to the foreland. We saw various fossils of plants and animals as primary resources to the coal formation and convinced personally about digenetic processes due to the strong bituminous smell of crushed rocks. Frequent gypsum crystals did not go by our mineralogical eyes on the mine walls.

Our SGA Student Chapter would like to invite all interested students to attend our meetings. For more information about us, please visit our web page: http://sga.dictor.net. We look forward to meeting and greeting you.

Field trip participants on the Grimsel Pass trip inside the hydropower plant, Switzerland.

The granite cave with well-developed quartz, fluorite and chlorite crystals in Grimsel Pass, Switzerland.

Students from Prague and Zürich inside the brown coal mine in Käpfnach, Switzerland.

News of the Society

SGA Ordinary Council Meeting, May 25, 2008 Quebec City, Canada

J. Pašava (SGA Executive Secretary), jan.pasava@geology.cz

Status of planning for SGA 2009 in Townsville – (R. Duckworth from EGRU, P. Williams)
The report was presented by P. Williams and R. Duckworth. SGA awards (SGA-Newmont Gold Medal, SGA-Barrick Young Scientist Award, Best paper in MD) will be presented during Opening Ceremony – (Opening – 15 min., Presentation of Awards – 30 min. and Presidential Address – 15 min.). Hard copies of conference proceedings (up to 4 pages extended abstracts – last 2 volumes published in Dublin2007 – each a. 800 pages) will be printed by EGRU and sold only on the basis of pre-orders offered on SGA 2009 Townsville abstract forms. R. Duckworth and P. Williams confirmed that SGA will own exclusive copyright for pdf abstracts to be offered through SGA e-shop. More detailed info on the meeting can be found on pages 23-28 and is displayed at the http://sga2009.jcu.edu.au/.

Reports of officers on Council and matters arising from these reports
Reports were submitted by SGA President Treasurer's Office, Promotion Manager, Executive Secretary, Editor of the SGA News, Editor of SGA website and VP for Europe and VP for North Africa.
After discussion Council approved the following:
-A new strategy how to attract more students to become SGA members including guidelines on how to set up a SGA chapter is needed.
-Regional Vice Presidents are encouraged to select important mineral deposit events in their region and contact SGA Promotion Manager to receive promotional material (portable SGA booth and other items).
-SGA Council members are encouraged to contribute to upcoming SGA News.
-G. Beaudoin will ask G. Stanley/C. Andrew for copyright transfer to SGA or the permission to sell the proceedings of the Dublin Proceedings.
-S. Bouhlel is encouraged to organize SGA workshop on the Metallogeny of North Africa in 2009. Industry involvement should be considered. D. Leach will work with S. Bouhlel to organize the workshop and develop a financial plan. Council would like to see a draft of the workshop and is ready to help.
-R. Herrington is encouraged to pursue his initiative to hold SGA student exploration workshops and to advertise them through SGA website and News.

Editorial matters and vote for a new co-editor
Council greatly appreciated efforts of L. Meinert and wished him all the best for his future career. Council unanimously approved P. Williams to replace L. Meinert as one of the Chief Editors, MD. P. Williams will participate in the upcoming editorial meeting with Springer (June 2008). The need for high-profile and/or good review papers was emphasized.

Summary of important events in 2008 (J. Pašava)
The summary was presented by J. Pašava with additions by G. Beaudoin and F. Tornos.

Discussion of proposals for SGA 2011 in Chile or Turkey – Council vote
The SGA Council had a difficult time deciding on the venue for the 2011 SGA Biennial Meeting because the quality of both proposals was very high. The final vote accepted the Chilean proposal. However, Council greatly appreciated the efforts of the Turkish group and expressed the hope that the proposal will be resubmitted for 2013 when the call for the SGA 2013 venue is announced. Some of Council members suggested a possible change of the venue - from Trabzon to Istanbul.

SGA-IAGOD relations (D. Groves)
In connection with the proposed changes to SGA Statutes SGA Council decided to remove names of the IAGOD Ex-officio members of SGA Council from SGA website.

Changes to SGA Statutes – Council vote (J. Pašava)
Council unanimously voted for suggested changes. Sabine Lange has distributed this document to all voting SGA members. 119 votes (109 electronic and 10 hard copies) were received. 117 votes were for and 2 against, thus the proposed modifications to SGA Constitution passed. The result of the ballot shall become effective seventy-five days from the date on which it was made known by the President.

Membership drive in 2008 and 2009 (D. Groves, P. Eilu, J. Pašava)
Following the approved SGA Membership Drive suggested by D. Groves and supervised by P. Eilu, the report on new membership from August 11, 2007 to May 14, 2008 with a table indicating how many applicants were sponsored by each of the Council members was presented by J. Pašava. Council members are encouraged to actively seek new members (at least 5 new members in 2008 and 2009).

Sponsorship drive in 2008 (D.Leach)
D. Leach noted that SGA has 16,305 EURO available for the SGA student program for Townsville. D. Leach will provide P. Williams with a list of corporate sponsors that donated money for the SGA 2007 Dublin student program. In order to increase corporate membership in SGA, all corporate sponsors of the SGA 2009 Townsville meeting will be offered 1 year free corporate membership in SGA (value of 300 EURO – to be implemented by P. Williams and D. Leach).

Strategy for biennial SGA workshops from 2010 (D. Groves)
Council approved with great thanks the concept of SGA Biennial Workshops from 2010 suggested by D. Groves and asked SGA President to come up with a concrete proposal for the next Council meeting.

Strategy to enhance nominations for SGA Awards in 2009
After discussion Council approved a new Award Committee chaired by D. Huston and with K. Kelley and F. Tornos (members). Jan Pašava will transfer "award agenda" to D. Huston who will begin advertising and actively seeking suitable candidates for all the three SGA awards (SGA-Newmont Gold Medal, SGA-Barrick Young Scientist Award, and Award for the best paper in Mineralium Deposita). Nominations for awards presented at the 2009 Townsville meeting have to be submitted to Council for the final vote in early 2009.

Policy for SGA sponsorship of meetings and discussion of business plan to handle requests for SGA sponsorship
Council approved that all requests for SGA sponsorship up to the amount of 1000 EURO can be decided by the Executive Committee. The requests that exceed this amount have to be approved by Council members.

Long term SGA strategy (D. Groves)
Besides discussing the financial plan presented by D. Leach, Council agreed that beginning with the SGA 2011 Meeting it will be important to establish a Memorandum of Understanding with the LOC in order to eliminate possible misunderstanding regarding the roles of the LOC and SGA Council and Council's expectations for the conference detailed in the Guidelines for Organizing a SGA Biennial Meeting.

Any other business
-New SGA VP for SA – (Dr. E. Ferrari replacement of Dr. C. Holmgren) - nomination by F. Tornos – unanimously approved.
-New SGA Council member (Dr. A. Piestrzynski replacement of Dr. W. Halter) – nomination by D. Groves and J. Pašava - unanimously approved.
-New SGA Promotion Manager (Dr. H. Frimmel replacement of Dr. G. Borg from 2009) – nomination by G. Borg and J. Pašava – unanimously approved.
-New committees (2008-2009) – appointed by SGA President
-Data Metallogenica – Council rejected request from A. Goode to permit AMIRA to include contributions from freely available SGA MD Archive on the Data Metallogenica site. Council also declined a request to become a Founding Sponsor of DM.
-Activities of the SGA Student Chapter Prague – request for 2008 budget – Council approved requested 1000 EURO budget for planned activities. Council also asked for a list of members and planned "membership drive" related to its future links with Swiss students.

Date and place of the next Council Meeting
The next Council meeting will be organized by H. Frimmel in Wuerzburg, Germany (April 3, 2009).

LIST OF NEW SGA MEMBERS (MAY 20-NOVEMBER 18, 2008)

71 Regular Members and 40 Student Members applied for membership from May 20 to November 18, 2008

REGULAR MEMBERS

Mr. Hugo CARANZA Las Marias 4942 Chacras de Coria, Lujan Mendoza 5505 ARGENTINA
Mr. Cepparo GROSSO PABLOSILEX ARGENTINA S.A. Barcala 2036, Godoy CruzMendoza 5507 ARGENTINA
Mr. Gabriel GOMEZ SILEX ARGENTINA S.A. San Martin Sur 499 – Piso 7 – Depto 6 Godoy Cruz, Mendoza 5501 ARGENTINA
Dr. Mabel LANFRANCHINI 64 No 3, La Plata 1900 Buenos Aires ARGENTINA
Dr. Neil ALLEN 14 Station Lane Exton Tasmania 7303 AUSTRALIA
Mr. Matthew BROWN Ivanhoe Mines P.O. Box 9279 Pacific Paradise, 4564, QLD AUSTRALIA
Dr. Warick BROWN WESTAUSTRALIAN GAS & POWER P.O. Box 198 West Perth WA 6872 AUSTRALIA
Dr. Warwick CROWE Fugra Airborne Surveys 65 Brockway Rd Floreat, Locked Bay 6, Wembley 6014 Western Australia AUSTRALIA
Mr. John DOBE Locked Bag 12 Cloisters Square Perth 6850 WA AUSTRALIA
Dr. Rowena DUCKWORTH SEES, James Cook University, Townsville QLD 4811 Quensland AUSTRALIA
Dr. Paul HEITHERSAY Executive Director Minerals and Energy Resources Primary Industries and Resources South Australia Level 7/101 Grenfell Street Adelaide, South Australia 5000 AUSTRALIA
Mr. Benjamin JONES PO Box 104 Omeo 3898, Victoria AUSTRALIA
Mr. Pierre-Alain WULSER 80 Leader St. 5035 Ferestville SA AUSTRALIA
Mr. Osvaldo ARCE Av. 20 de Octubre No 1963 La Paz BOLIVIA
Dr. Francisco Javier RIOS CDTN/CNEN Av. Presidente Antonio Carlos, 6627Campus UFMG-Pampulha, CEP31270-901 Caixa Postal 941 CEP 30123-970 Belo Horizonte-MG BRAZIL
Mr. Bertrand BRASSARD C.P. 116 Rue L'Académie Val d'Or, Québec, J9P 4N9 CANADA
Mr. Antoine FOURNIER 649 3éme Avenue Val-dOr, Quebec, J9P 1S7 CANADA
Mr. Sergio GELCICH, PhD 6 Adelaide Street East Suite 300 Toronto, Ontario M5C 1H6 CANADA
Prof. Carl Michael LESHER Mineral Exploration Research Centre Dept of Earth Sciences, Laurentian University 935 Ramsey Lake Road Sudbury, ON, P3E 2W8 CANADA
Mr. Edgar LOCKHART 805-933 Hornby St. Vancouver BC V6Z 3G4 CANADA
Mr. Luke OOTES PO Box 1500 4601b – 52nd Ave Yellowknife, NT, X1A 2R3 CANADA
Mr. Koji HIRAI Pan Pacific Copper Co., Ltd. Av. Apoquindo 3846 Piso 11, Las Condes, Santiago CHILE
Prof. Zengaian HOU Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Zhenging LI Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Xiaofei PAN Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Mr. Peng RUNMIN China University of Geosciences, Beijing 29 Xueyuan Road Beijing 100083 CHINA
Ass. Prof. Shihong TIAN Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Zhusen YANG Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Mr. Luis ALFONSO (Arteaga) Cll 113 #7-21 Teleport Bussiness Park – Torre A – O 1206 Bogota COLOMBIA
Mr. Edgar Pillajo GAVIDIA Calle 16 de Septiembre 471 y 9 de octubre, Edificio Wolgemut piso 6 Quito ECUADOR
Mr. Mathias FORSS Ab Scandinavian Geopod, Ltd. Britagranden 3A FIN- 02 700 Grankulla FINLAND

Ms Hiu Lai LAM RM 924, Tin Cheung Hse, Tin Ping Est, Sheung Shui, N.T. HONG KONG
Dr. Paolo GAROFALO Dept. Earth and Environmental Studies University Bologna Piazza Porta S. Donato 1 Bologna ITALY
Dr. Stuart Simons Hot Solutions Ltd. PO Box 32-125, Devonport Auckland 1330 NEW ZEALAND
Mr. Jorge Gilberto ACOSTA ALE INGEMMET Av. Canada #1470, San Borja Lima 41 PERU
Mr. José Ricardo ARCE Av. Petit Thouars 4380, Miraflores Lima PERU
Mr. Edgar Dennis ASTETE HUAYLLACalle Lord Nelson 410 Miraflores, Lima PERU
Ms. Lucy Elena BARREDA BUTRON Juan dec Aliaga #621 Torre II, Dpto. 1001 Magdalena del Mar Lima PERU
Mr. Deny Martin BAYONACalle Los Zonzales 130Of. 301 Lima 27 PERU
Mr. Amadeo Severo CAHUAYA PONCE Calle los Alisios 250, Sta Catalina La Vistoria, Lima PERU
Mr. Raul CARBAJAL Av. Larco 1301 of 2102 Miraflores, Lima 18 PERU
Mr. Ivan Ramirez CARRILLO Av. La Merced 1015 Edif D – 204 Santiago de Surco, Lima PERU
Mr. Gerald DEINZER Jr. Castilla la Vieja 173, Urb. La Castellana Surco, Lima PERU
Mr. Daniel HINOSTROZA ZUNIGA Votorantim Metals – Cajamarquilla S.A. Paz Soldan 170, Oficina 501A San Isidro, Lima 27 PERU
Mr. Jorge MARTINEZ Jr Lomas de los Pensamientos Nº 150 Dpto 201, Santiago de Surco – Lima 33 PERU
Mr. Carlos Edmundo MIRANDA FARFAN Calle Navarra 109, Dpto. 201 Urb. La Capilla, La Molina Lima PERU
Dr. Cesar MUNOZ Jr. Geronimo Balarezo 413, Chorrillos Lima 9 PERU
Mr. Javier OCAMPO CERRADA Jr. Montero Rosas 289 Barranco, Lima PERU
Mr. Edgar PICHARDO Av. Parque Norte 724, Urb Corraz San Isidro, Lima PERU
Ms. Ada Isabel RAMOS HUAITA Av. Carlos Villaran No 790 Santa Catarina, La Victoria – Lima PERU
Mr. Juan Carlos SALAZAR CACEDES Carlos Villaran 790 Santa Catalina La Victoria - Lima PERU
Mr. Carlos Alberto SANDOVAL CORDOVA Calle 9 – Mz J4 Lote 05 URB. Puerte de Oro Los Olivos, Lima PERU
Mr. Nancy TUANAMA Votorantim Metals – Cajamarquilla S.A. Paz Soldan 170, Oficina 501A San Isidro, Lima 27 PERU
Mr. Rafael VERA MEDINA Av. Benavides 4135 casa 3 Urb. Chama, Santiago de Surco Lima 033 PERU
Mr. Gustavo Enrique VILLON DUROUD XSTRATA PERU S.A. Prolongacion Los Faisanes 266 Dpto 402 Surquillo, Lima 034 PERU
Mr. Jonathan ZAVALETA CURASI Alfonzo Ugarte II, Etapa Mz L4 Lote 11 Gregorio Albarracin District Tacna City PERU
Mr. Igor SHARYGIN V. S. Sobolev Institute of Geology and Mineralogy SB RAS 630090 Novosibirsk Koptyuga prospect 3 RUSSIA
Mr. Risto Artturi VIRKKUNEN BOX 96 SE – 921 22 Lycksele SWEDEN
Mr. David Tripod 14, Rue Etienne-Curmont 1204 Geneva SWITZERLAND
Mr. Nasuh AYDIN Stratex Madencilik Sanayi ve Ticaret Ltd. Iran Caddesi, 53/6, G.O.P. 06700 - Ankara TURKEY
Mrs. Selmin KANDIRALI Uysal Zryabey Cad. Tuba apt. 16/12 06520 Balgat – Ankara TURKEY
Mr. Osman KURTULUS 3272 Caddesi, Yesiller Sitesi C-block No. 8 Yasamkent, Cayyolu Yenimahalle TURKEY
Mr. Efdal OLGER Stratex Madencilik Sanayi ve Ticaret Ltd. Iran Caddesi, 53/6, G.O.P. 06700 - Ankara TURKEY
Mr. Cem TEKIZBAS Soyaltin Sitesi Dolunay sok No:15 Beytepe koys Bilkent Ankara TURKEY
Mr. Bahri YILDIZ Gen. Manager Stratex Madencilik Sanayi ve Ticaret Ltd. Iran Caddesi, 53/6, G.O.P. 06700 - Ankara TURKEY
Mr. James EDWARDS 1 Well Green Close Saffron Waloen Essex CBII 4BA UK
Mr. Miller O´PREY 6 Spinners Court , Comber Newtownards, Co. Down BT 23 5WL , Northern Ireland UK
Mr. Jose MANRIQUE 12488 W. 84th Dr. Arvada CO 80005 USA
Ms. Melissa MATEER 132 W.Pine St. Elko NV 89801 USA

STUDENT MEMBERS

Mr. Miguel Sebastian JOVIC Instituto de Recursos Minerales Calle 64, n. 3, La Plata 1900 BUENOS
Miss Jacinthe LEGARE'-LAGANIERE 25 II A Chemin du Foulon Sillery, Québec GIT IX6 CANADA
Mr. Pablo BERNABE Ochandia 164 S, Vallenar CHILE
Mr. Claudio FUENTES Colo Colo n° 131 interior Concepción región del Bío Bío CHILE
Mr. Andres MESTRE Galvarino 347, dpto 907 Concepcion CHILE
Zheng LI Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Yingchao LIU Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Yucai SONG Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Ms Juanjuan TAN 3502 Yifu Building 2 (East Gate) School of Earth and Space Sciences Peking University Beijing CHINA
Zhiming YANG Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Xiaohu WANG Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Zhaolin WANG Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Hongrui ZHANG Institute of Geology CAGS Baiwanzhuang Road 26 Beijing 100037 CHINA
Mrs. Alexandra AGOJA Calle 54 sur No 24A-44 Int 3 Apt 104 Bogota COLOMBIA
Mr. John Alexandre BERNAL Calle 54 sur No 24A-44 Int 3 Apt 104 Bogota COLOMBIA

Mr. Mathias BACKMAN Rauhankatu 19 E 131 20100 Turku FINLAND
Mr. Anton GRINDGARDS Stórlidvágen 31 64 460 Hárkmeri FINLAND
Mr. Thomas LEVIN Betaniankatu 1 B 20 20 810 Turku FINLAND
Mr. Matias SILJANDER Gertrudsgatan 3A4 20 500 Turku FINLAND
Mr. Lingang XU Institute of Mineralogy and Mineral Resources Technical University of Clausthal Adolph – Roemer Str. 2A 38 678 Clausthal – Zellerfeld GERMANY
Mr. Mesenia ALEGRE TORRES Calle Luis Uzategui 610 Santiago – Cusco PERU
Mr. Josue Henverly ALVAREZ NIHUA Urb: Kawarina – Quatro Terres, dep 303 Cusco PERU
Miss Andia AYMA Universidad Nacional Mayor de San Marcos Lima 07 PERU
Karina Isabel CALDERON GUILLERMO Coop. Jorge Basadre E-4 Alto de la Alianza, Tacna PERU
Ms. Ana Cecilia CERDAN VASQUEZ Via de Euitamicato No 1377 Cajamarca PERU
Mr. Felix Abraham CORNELIO ORBEGOSO Av. Paseo dela Republica 4886, edif C-101 Lima PERU
Mr. Eder Victor LANADO OVIEDO Calle Bayoneta No 739 Cusco PERU
Ms. Sandra LOAYZA GALVEZ Urbanizacion Kennedy "A" D-9Wanchaq, Cusco PERU
Mr. Gustavo Mouepaza MOLLOMUANCA Calle Las Pisinas 113 Arequipa PERU
Mr. Deysi Mariela PACO ESTRADA Av. Canada #1470, San Borja Lima 41 PERU
Mr. Victor Enrique PALOMINO MUELLE Calle Pumapaccha 264 Barrio San Blas Cusco PERU
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Mr. Luis Enrique SINA ESPINOZA Avenida Tarata 540, Leoncio Prado Tacna PERU
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Miss Rita Caldas Rua Damião de Góis nº 36, 7ºEsq. Alfornelos 2700-227 Amadora PORTUGAL
Mr. Hildebrando LEAL MEJIA Departamento de Cristalografia, Mineralogia y Dep. Minerales Facultad de Geologia – Unioversidad de Barcelona 08028 Barcelona SPAIN
Mr. Tobias BAUER Domherregrand 16 974 54 Lulea SWEDEN

The SGA website

Georges Beaudoin, Chief Editor SGA website
Université Laval, Québec,Canada, georges.beaudoin@ggl.ulaval.ca

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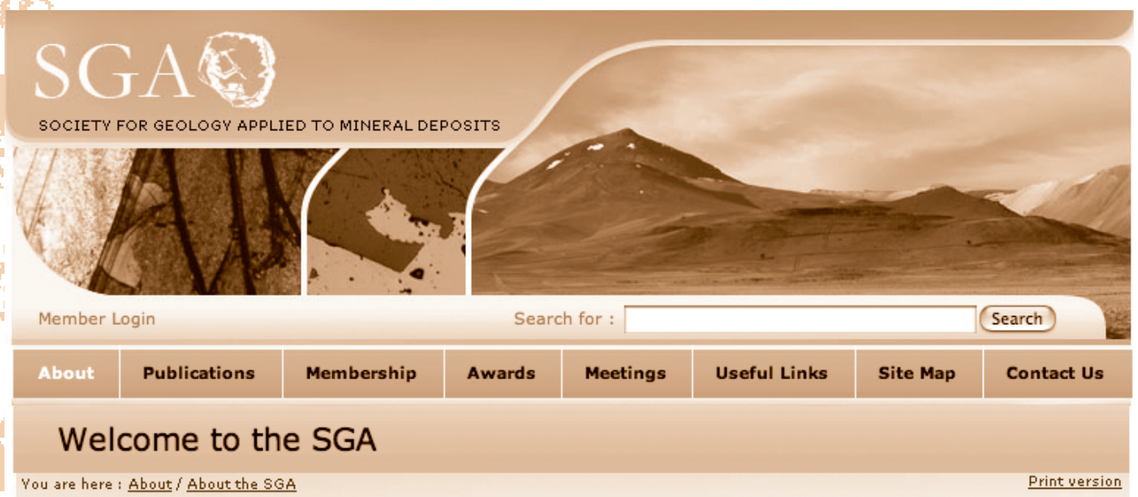

>>> page 1 Metallogeny and the evolution of the Australian continent

3520 to 2840 Ma, hosts many of the oldest known examples of several deposit types, including the oldest volcanic-hosted massive sulphide (VHMS; 3490 Ma), porphyry Mo-Cu (3320 Ma), epithermal Au-Ag (3450 Ma) and lode Au deposits (3400 Ma: Huston et al., 2002). With the exception of the Wodgina Ta-Sn pegmatite system (2840 Ma: 1 [number refers to location on Figure 1]), however, these deposits are small, and mostly sub-economic.

Economically, the most important part of the Pilbara Craton is the Hamersley Basin, which contains one of the largest accumulations of high-grade, hematite-rich iron ore in the world, with total resources of 3.5 Gt (Clout and Simonson, 2005). These deposits, which include the giant Mt Whaleback (2) and Mt Tom Price (3) deposits, are hosted by Hamersley- (Superior-) type banded iron formations that were deposited in two pulses at 2590 and 2450 Ma. Formation of the iron ore deposits from banded iron formation, however, was the consequence of moderate-temperature, hydrothermal alteration that removed deleterious components of the iron formation, leaving behind high-grade iron ore (Clout and Simonson, 2005). Geochronological constraints on this alteration (Müller et al., 2005) suggest that it is associated with the Glenburgh Orogeny and the final amalgamation of the WAC. Excursion 3 (see page 27), "Iron ore deposits, Hamersley and Yilgarn, Western Australia" examines the geology and origin of this major province.

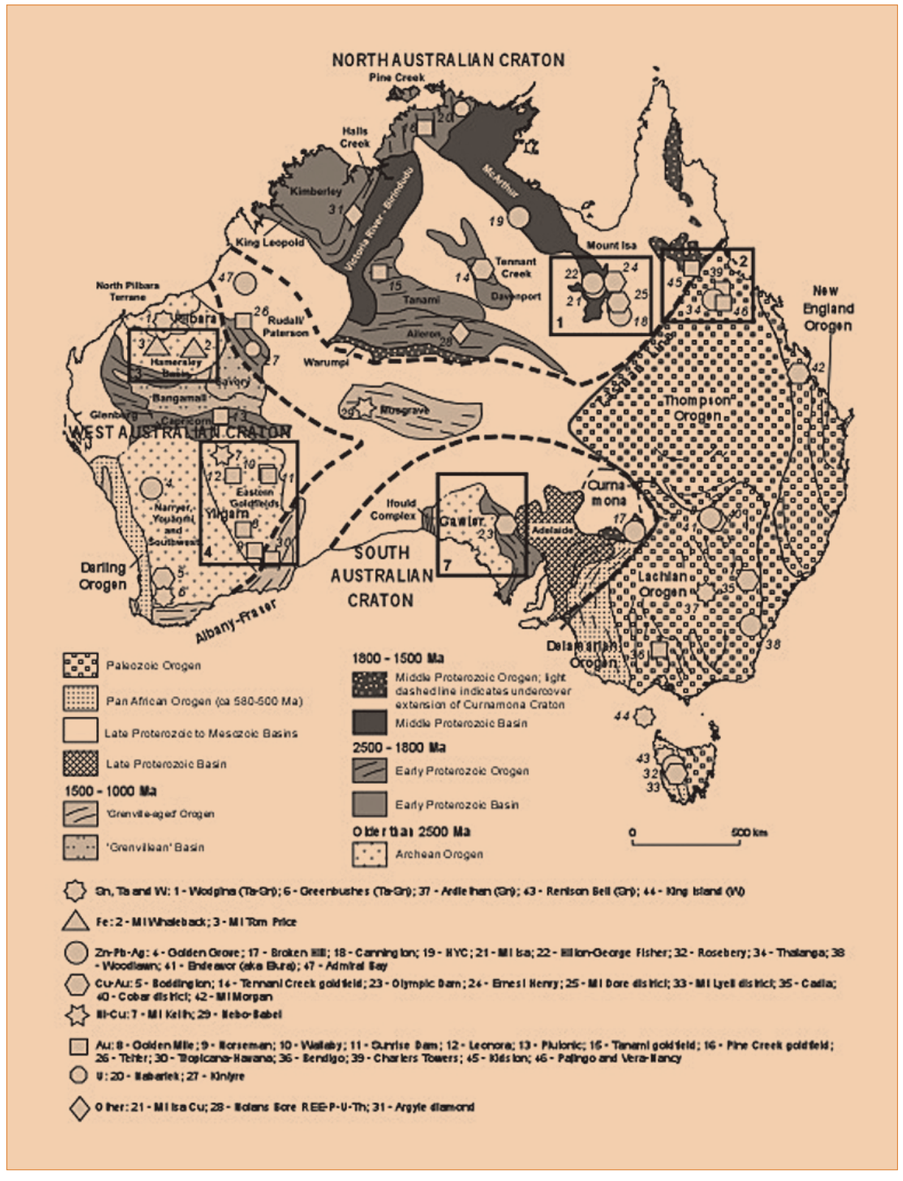

Figure 1: Generalized tectonic map of Australia showing the location of major geologic provinces, important mineral deposits and areas to be visited by excursions (modified after Betts et al., 2002). Deposit numbers are keyed to text.

To the south of the Hamersley Basin, the Glenburgh Terrane is only weakly mineralised, but the Yilgarn Craton is one of the most mineralised provinces known. This craton youngs from west to east, with the western Narryer, Youanmi and Southwest provinces forming between 3800 and 2900 Ma and the Eastern Goldfields Province forming between 2940 and 2660 Ma, probably as a back-arc basin developed on older crust. Relative to the Eastern Goldfields Province, the western provinces are not strongly mineralised. They do contain major and world class deposits, however, including the ~2950 Ma Golden Grove VHMS district (2.7 Mt Zn + Pb + Cu: Huston et al., 2006 [global resources for Zn-Pb(Cu) deposits from this reference, unless otherwise noted]: 4), the 2700-2615 Ma Boddington Au-Cu deposit (>800 t Au: McCuaig et al., 2001: 5) and the ~2527 Ma Greenbush pegmatite Ta-Sn deposit (Partington et al., 1995: 6).

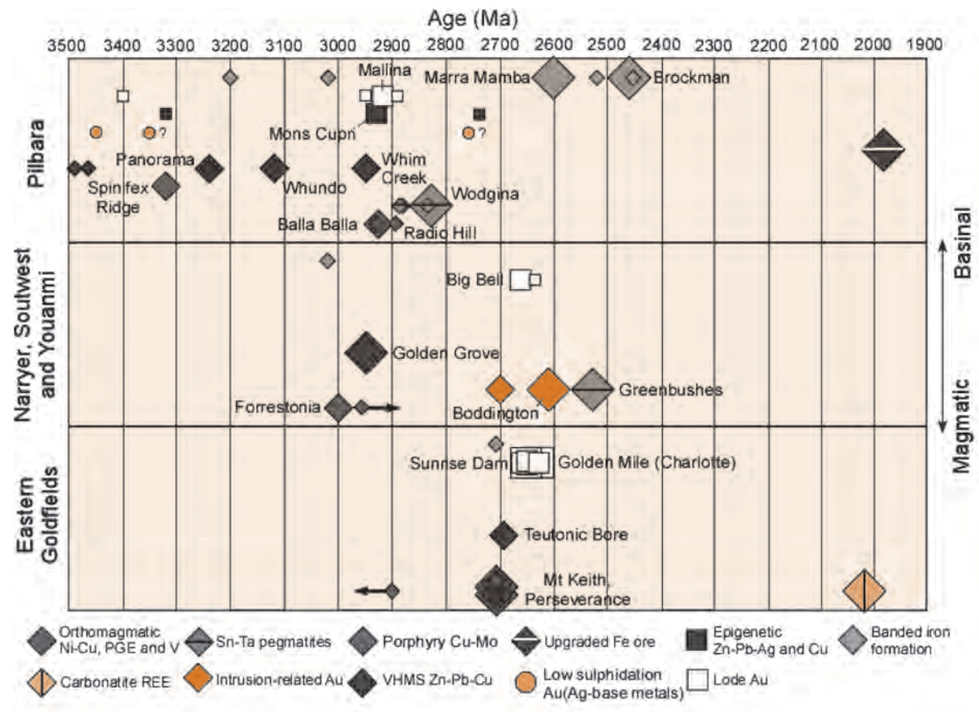

Figure 2: Temporal distribution of Australian mineral deposits between 3500 and 1900 Ma.

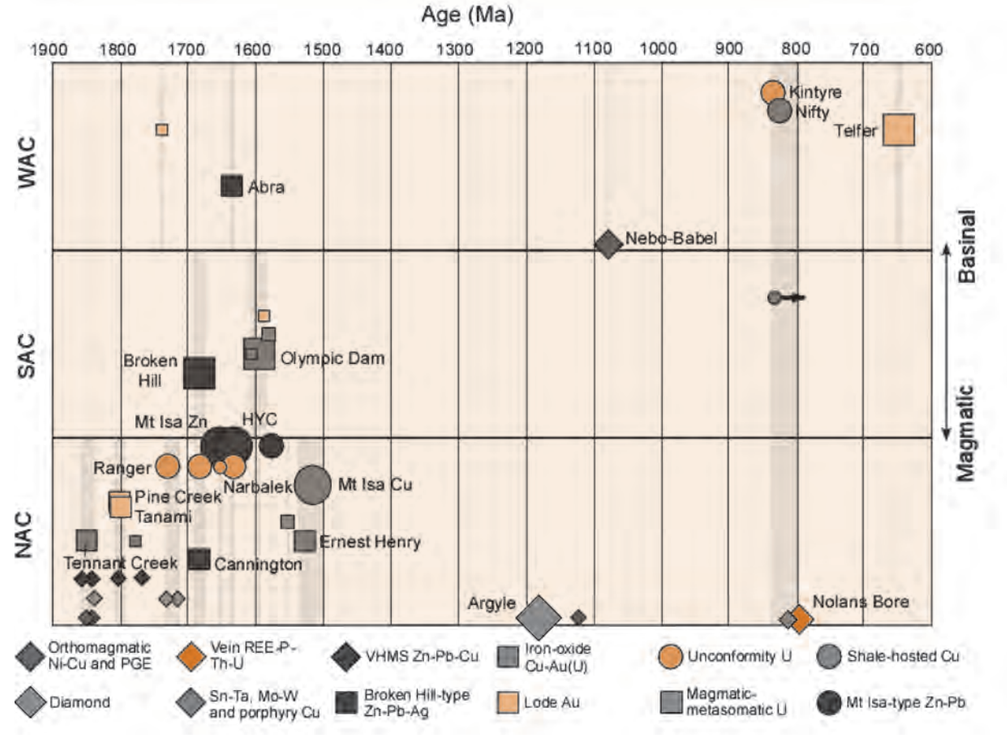

Figure 3: Temporal distribution of Australian mineral deposits between 1900 and 600 Ma. Pink bands indicate local metallogenic epochs.

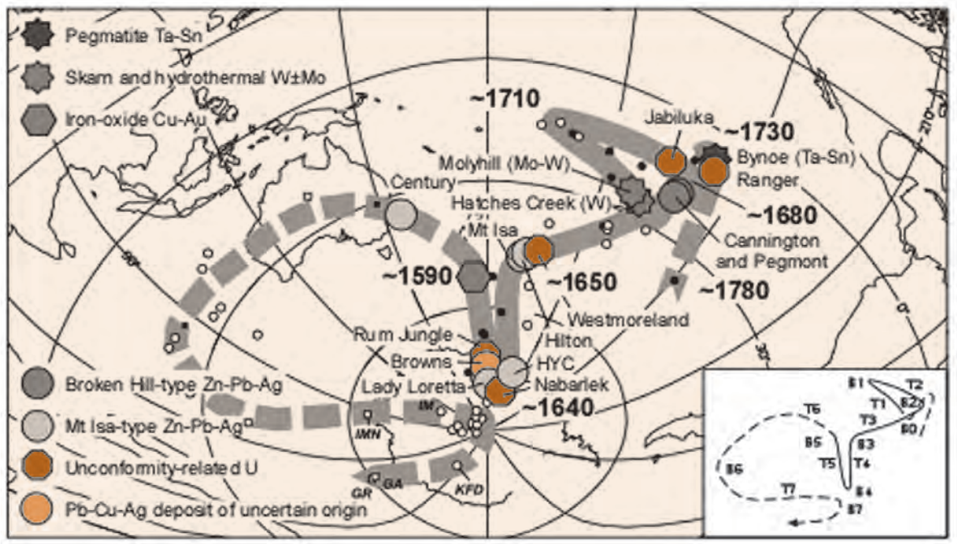

Figure 4: Apparent polar wander path for the North Australian Craton between 1780 and 1500 Ma showing the timing of major mineral deposits (modified after Idnurm, 2000).

The Eastern Goldfields Province (Fig. 1), along with the Abitibi Subprovince in Canada, is one of the two largest Archean lode Au provinces known, with global resources of over 9200 t (Robert et al., 2005). Unlike the Abitibi Subprovince, it is also a major Ni producer (global resource of 11.7 Mt Ni: Hoatson et al., 2006) but contains only minor Zn (0.5 Mt). The Ni-Cu deposits in the Eastern Goldfields Province, for example the Mt Keith deposit (7), are mostly orthomagmatic deposits associated with ~2705 Ma komatiites that can be traced through much of the province (Hoatson et al., 2006). Lode Au deposits (8-13) are localised mostly within greenstone belts, closely associated with second or third order structures related to major, throughgoing shear zones that commonly penetrate into the lower crust (see Solomon and Groves, 2000 for a review). Although many of the deposits, including the main stage of mineralisation at the Golden Mile deposit (global resources 1984 t Au: Goldfarb et al., 2005), appeared to have formed over the narrow period of ~2640-2620 Ma (Groves et al., 2000), more recent data suggest the presence of a prolonged period of mineralisation between ~2680-2620 Ma (Robert et al., 2005). Excursion 4 (see page 27), "Yilgarn Craton, Western Australia; nickel & gold" examines deposits of both Au and Ni-Cu in this world-class mineral province.

1900-600 Ma: Growth and amalgamation of the WAC, NAC and SAC

Of the major periods of growth of the Australian continent, the period time between 1900 and 1500 Ma is most contentious, with a number of geodynamic scenarios advanced, including fixist (e.g., Etheridge et al., 1987), mobilist (e.g. Myers et al., 1996; Betts et al., 2002; Cawood and Korsch, 2008) and extensional (e.g. Gibson et al., 2008) models (see Fraser et al., 2007 for discussion). Good evidence for subduction is present for some parts of this period (e.g., Sheppard et al., 2001; Glass, 2007); therefore, for this contribution, the mobilist framework, inferring plate margin processes such as subduction, is used to describe the associated metallogenesis of this period.

The earliest deposits in the NAC, which include VHMS, orthomagmatic Ni-Cu and PGE, and porphyry Cu deposits, were formed between 1870 and 1835 Ma (Fig. 3). They were associated with subduction (Sheppard et al., 2001) that amalgamated the Kimberley Craton with the Pine Creek Province and the Tanami-Tennant Creek Block to form the NAC. Between 1850 and 1845 Ma (Fraser et al., 2008), iron-oxide Cu-Au (IOCG) deposits in the Tennant Creek goldfield (14) were formed during basin inversion, possibly associated with convergence between the Tanami-Tennant Block and the Aileron Province to the south (Fig. 1). At about 1830 Ma the Capricorn Orogeny took place, which can be considered as the last suturing event that led to the final amalgation of the Pilbara and Yilgarn Craton (Cawood and Tyler, 2004). The Capricorn Orogen includes important volcano-sedimentary and sedimentary basins, containing the Magellan nonsulphide Pb deposit in the Earaheedy Basin (4.8 Mt Zn: Pirajno and Bagas, 2008) and the Abra polymetallic deposit in the Edmund Basin (2.8 Mt Pb equivalent: Pirajno et al., 2008).

After ~1825 Ma, convergence shifted to the southern margin of the Aileron Province, which was an important control on metallogenesis in the NAC for nearly 200 million years (cf. Scrimgeour, 2006). Gold mineralisation in the Tanami (300 t: Huston et al., 2007a; 15) and Pine Creek (190 t: Ahmad et al. [1999] updated to include new data; 16) mineral provinces, which have ages of 1810-1795 Ma (Cross et al., 2005; Compston and Matthai, 1994) that temporally overlap granite intrusion, may be an inboard manifestation of this convergence. Closer to the southern margin of the NAC, small VHMS and possible IOCG deposits formed between 1810 and 1765 Ma (Hussey et al., 2005).

The period between 1700 and 1500 Ma was one of the most prolific metallogenic periods in Australia (Fig. 3). During this time, major Zn-Pb-Ag, IOCG and unconformity U deposits developed in the NAC and SAC. The oldest of these deposits are Broken Hill-type Zn-Pb-Ag deposits, which formed in deep water turbiditic successions in the eastern parts of both the NAC and SAC at 1690-1670 Ma (Figs. 1 and 3).

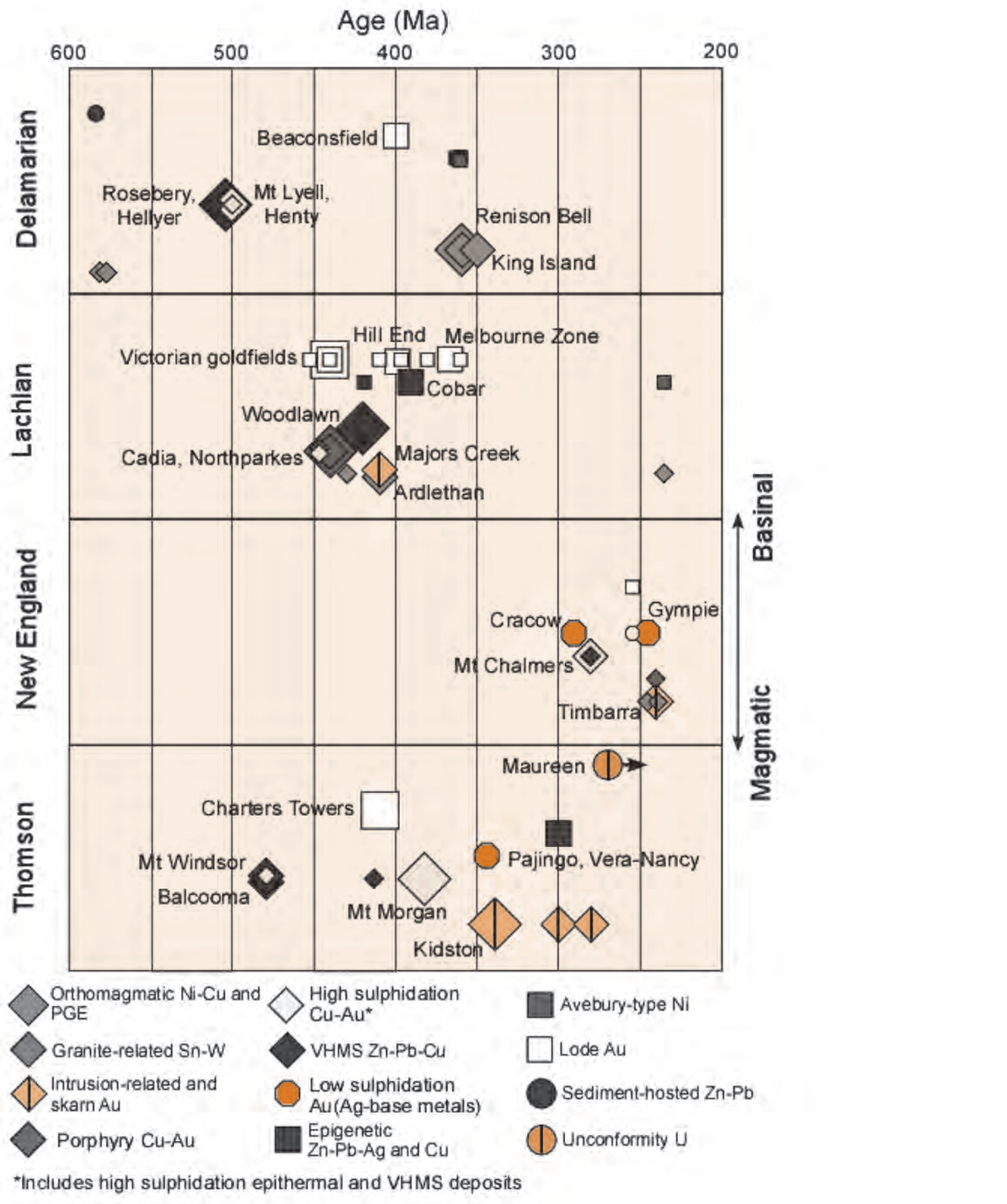

Figure 5: Temporal distribution of Australian mineral deposits between 600 and 200 Ma.

Broken Hill-type deposits in the eastern part of the NAC are one subject of excursion 1, "Mt Isa/Cloncurry districts, NW Queensland" (see page 27).

In the NAC, many later Paleoproterozoic deposits are temporally associated with bends in the apparent polar wander path (Fig. 4: Idnurm, 2000), suggesting that these deposits may have formed in response to major changes in plate motion. One of the most significant of these bends was a "U-turn" at ~1640 Ma. This event, which is interpreted to be the consequence of the accretion of the Warumpi Province onto the southern margin of the Aileron Province (Scrimgeour et al., 2005), coincided with the formation of the HYC (30 Mt Zn + Pb: 19) and Lady Loretta Mt Isa-type Zn-Pb-Ag deposits, and the Nabarlek (20) unconformity-related U deposit (9.2 kt U: McKay and Miezitis, 2001; Figs. 3 and 4). Other deposits that coincide with bends in the polar wander path include the Mt Isa (20 Mt Zn + Pb: 21) and Hilton-George Fisher (37 Mt Zn + Pb: 22) Mt Isa-type Zn-Pb deposits. These deposits are another subject of Excursion 1 (see page 27).

The younger part of the 1700-1500 Ma mineralisation epoch was dominated by IOCG deposits, including the ~1590 Ma (Johnson and Cross, 1995; Haynes et al. 1995) Olympic Dam deposit (global resources of 38.1 Mt Cu, 190 t Au and 1270 kt U: Williams et al., 2005: 23), one of the largest known metal accumulations in the world. This deposit, and possibly the more recently discovered, though smaller, Prominent Hill (1.5 Mt Cu and 49 t Au: Belpario et al., 2007) and Carrapateena deposits, appear to be related to a major suture between interpreted Archean and Proterozoic crustal bocks within the SAC (Lyons and Goleby, 2005) and are the subjects of Excursion 7, "Olympic Dam-Mt Painter Cu-Au-U, South Australia" (see page 27).

Iron-oxide Cu-Au deposits in the eastern part of the NAC appear to be younger, with ages mostly around 1530-1500 Ma (Williams et al., 2005 and references therein). These deposits, which include the Ernest Henry (1.8 Mt Cu and 90 t Au: Williams et al., 2005: 24) and Mt Dore group of deposits (3.1 Mt Cu and 159 t Au [www.ivanhoeaustralia.com; accessed 8 November 2008]: 25) will also be visited as part of Excursion 1. Preliminary interpretations of recently acquired seismic data (Geoscience Australia, unpublished data) suggest that the Ernest Henry deposit may also be spatially associated with a major suture. The Mt Isa shale-hosted Cu orebody (21), with differs from IOCG deposits in most respects, appears to have a similar timing (~1520 Ma: Perkins et al., 1999), suggesting a possible link. This orebody is also examined during Excursion 1.

Although the period between 1500 and 600 Ma has been considered a relatively quiet time in the metallogensis of Australia, recent discoveries and new data are highlighting the potential of this period. The most significant deposit is the Telfer deposit (1564 t Au: Goldfarb et al., 2005: 26) in the Paterson Province of the WAC, which is interpreted to be synchronous with ~650 Ma granites. The Paterson Province also contains shale-hosted Cu (Nifty) and unconformity-related U (Kintyre: 27) deposits that are interpreted to have formed at 850-800 Ma (R Maas and L Bagas, unpub. data; Huston et al., 2007b). This metallogenic event, which coincides temporally with Cu mineralisation in the Zambian Copper Belt (Selley et al., 2005), may be more widespread and is underexplored. The Nolans Bore REE-P-U (0.848 Mt REO, 3.9 Mt P2O5 and 5.11 kt U [http://arafuraresources.com.au, accessed 14 November 2008]; 28) deposit in the Aileron Province has an age of ~800 Ma (D Huston, R Maas and K Hussey, unpub. data).

Two significant recent discoveries in Australia may not be part of established metallogenic events in Australia. The Nebo-Babel orthomagmatic Ni-Cu deposit in the Musgrave Province, the largest Ni discovery in the last 11 years, is hosted by a chonolitic gabbronorite intrusion of the 1076 Ma of the Warakurna large igneous province (Wingate et al. 2004; Seat et al, 2007: 29), and the undated Tropicana-Havana lode gold system (30) occurs within the Mesoproterozoic Albany-Fraser Orogen although possibly in reworked Archean rocks. In addition, the giant Argyle diamond deposit (~30 million CM: 31) has an age of ~1170 Ma (Solomon and Groves, 2000). The Late Mesoproterozoic and Neoproterozoic time periods appear to be more significantly mineralised than historically thought in Australia.

600-220 Ma: Convergence along the eastern seaboard, the Tasman Orogen

With the exception of Mississippi Valley-type (MVT) Zn-Pb deposits in the Canning and Georgina Basins, Phanerozoic deposits in Australia are restricted to the Tasman Orogen, which forms the eastern seaboard from northern Queensland to Tasmania. This orogen contains Australia's most significant VHMS, epithermal and porphyry Cu-Au deposits as well as major lode Au and magmatic Sn provinces. The history of the Tasman Orogen can be divided into five tectonic cycles (Glen, 2005; Champion et al., in press): (1) the Delamarian cycle (600-490 Ma), (2) the Benambran cycle (490-430 Ma), (3) the Tabberabberan cycle (430-380 Ma; includes the Bindian Orogeny), (4) the Kanimblan cycle (380-250 Ma), and (5) the Hunter-Bowen cycle (350-230 Ma). Typically these cycles begin with an extensional event that terminated the previous cycle and end in a major orogeny.

From the Late Neoproterozoic to the mid-Cambrian (600-515 Ma) the geological history of eastern Australia was characterised by continental rifting and ocean opening leading to the formation of a passive margin (Li et al., 2008). By 515 Ma, however, subduction commenced in southeastern Australia, with an arc-continent collision at 510-505 Ma (Crawford and Berry, 1992). Although no significant mineral deposits are known of this age, small orthomagmatic Ni-Cu deposits, possibly of this age are present in the Koonenbery region, New South Wales, and in western Tasmania (Gilmore et al., 2007; Seymour et al., 2007), and small sediment-hosted Zn-Pb deposits are present in rocks of this age, also in the Koonenbery region (Gilmore et al., 2007).

The most significant ore deposits of the Delamarian cycle are VHMS and related deposits within the Mt Read Volcanics of western Tasmania. These deposits include both Zn-Pb-rich massive sulphide deposits (e.g. Hellyer and Rosebery (32): 11.1 Mt Zn + Pb), that are generally interpreted to have formed during or slightly after deposition of the host volcanic and sedimentary host rocks, and Cu-Au (e.g. Mt Lyell field (33): 3.0 Mt Cu and 96 Mt Au: Seymour et al., 2007) and Au-rich (e.g. Henty deposit) largely disseminated deposits associated with high sulphidation alteration assemblages (Green et al., 1981; Gemmell and Large, 1992; Huston and Kamprad, 2001). Zircon U-Pb dating of the host units to the Zn-Pb-rich deposits suggest an age of mineralisation of ~505 Ma (Black et al., 1997), and molybdenite Re-Os dating from the Prince Lyell deposit indicates an age of ~500 Ma for the disseminated Cu-Au deposits (D Huston, R Creaser and K Denwar, unpub. data).

Crawford and Berry (1992) proposed a model in which the Mount Read Volcanics formed after an arc-continent collision. Subduction associated with convergence between these two blocks was initially east-dipping, but, following collision, the direction of subduction flipped, with the Mt Read Volcanics forming above a west-dipping subduction zone, possibly in a backarc setting. In this model, the disseminated Cu-Au deposits formed closer to the inferred arc (i.e. in the east) whereas the Zn-Pb-rich deposits formed more in the back-arc position.

Renewal of subduction in northern Queensland during the first part of the Benambran cycle resulted in the deposition of volcanic and associated sedimentary rocks at ~480 Ma in the Seventy Mile Range Group and Balcooma Metavolcanic Group (Hutton et al., 1997; M Fanning, unpub. data in Rae, 2001). These rocks host VHMS deposits such as the Thalanga deposit (34) with combined resources of 1.8 Mt Zn + Pb and 0.5 Mt Cu (Hutton and Withnall, 2007). These deposits, as well as younger lode gold and intrusion related gold (see below) are examined in Excursion 2, "North Queensland gold & base metal deposits" (see page 27).

The most significant deposits of the Benambran cycle formed near its conclusion, although in quite different tectonic environments. Porphyry Cu-Au deposits and related high sulphidation Cu-Au and low sulphidation Au deposits formed at ~440 Ma largely associated with shoshonitic volcanic centres within the Macquarie Arc of east-central New South Wales (Crawford et al., 2007). This event, which includes the Cadia district (4.24 Mt Au and 980 t Au: Cooke et al., 2007: 35), was associated with an intraoceanic arc (Crawford et al., 2007) that amalgamated onto the Australian Craton during the Benambran Orogeny.

In contrast, the bulk of lode gold deposits in the Victorian goldfields, such as the Bendigo deposit (36), formed between 455-435 Ma (probably 2000 t out of total resources of 2500 t: data from Phillips et al., 2003; Bierlein et al., 2001). This period, which in the goldfields was characterised by shortening associated with the Benambran Orogeny (Vandenberg et al., 2000), overlaps with the development of the Macquarie Arc, indicating that either arc formation and accretion were very rapid, or that stress regimes changed rapidly in space during closing of the Benambran cycle.

Like the Benambran cycle, the Tabberabberan cycle (including the Bindian Orogeny) is marked by quite variable mineral deposits, included granite-related Sn-W, VHMS, lode gold and intrusion-related gold deposits. The Sn-W deposits, which include the Ardlethan breccia pipe deposits (Ren et al., 1995: 37), are associated with strongly fractionated largely S-type, 435-410 Ma granites within the Wagga Sn belt, which extends from northern Victoria into central New South Wales (Blevin and Chappell, 1995). Volcanic-hosted massive sulphide deposits in southeastern New South Wales and northeastern Victoria (collective resources totalling 5.2 Mt Zn + Pb and 0.9 Mt Cu: updated data from Davis, 1990), including the Woodlawn deposit (38), were also deposited within extensional basins at ~417 Ma (L Black, unpub data). Although not as rich as the Benambran systems, 420-400 Ma lode and intrusion related gold events are present in northern Tasmania (Beaconsfield: Bierlein et al., 2005), the Victorian goldfields (Bierlein et al., 2001), New South Wales (Hill End Trough: Downes et al., 2008; Dargues Reef: McQueen and Perkins, 1995) and northern Queensland (Charters Towers: Kreuzer, 2005: 39). These events overlap with the Bindian Orogeny (Glen, 2005; Champion et al., in press).

The 390-380 Ma Tabberabberan Orogeny (Glen, 2005; Champion et al., in press), which marked the end of the Tabberabberan cycle, is also characterised by lode gold deposits. Lode gold deposits of this age include deposits in the eastern Victorian goldfields (e.g. Melbourne Zone deposits and Fosterville deposit: Phillips et al., 2003; Bierlein et al., 2001), smaller deposits in Tasmania (Bierlein et al., 2005), and possibly some deposits in the Hill End Trough (Downes et al., 2008). In addition to the Bindian-related gold events, the basin inversion associated with the Bindian Orogeny resulted in the deposition of epigenetic Cu-Au (40) and Zn-Pb (41) deposits in the Cobar district, west central New South Wales during this period (Sun et al., 2000).

The Mt Morgan Cu-Au deposit (42), in central Queensland, formed within the Calliope Arc during or just before the intrusion of the Mt Morgan Tonalite at ~381 Ma (Golding et al., 1993). Formation of the deposit in an arc that overlaps in time with the Tabberabberan Orogeny further to the south re-emphasises the likelihood of major coeval changes in stress regimes spatially in the Lachlan Orogen.

During much of the 380-350 Ma Kanimblan cycle, much of the Lachlan Orogen underwent extension that terminated at ~350 Ma with the Kanimblan Orogeny (Champion et al., in press). Mineralisation associated with this cycle is relatively restricted, with the most significant deposits being granite-related Sn and W deposits in Tasmania (e.g. Renison Bell (43): Patterson et al., 1981 and King Island (44): Seymour et al., 2007).

The 350-220 Ma Hunter-Bowen cycle involved the development of arcs, backarc basins and thrust belts associated with west dipping subduction, particularly of rocks in the New England Orogen. In addition, Permo-Carboniferous magmatism was extensive through much of north Queensland during parts of this cycle (Champion et al., in press). Deposits associated with the early part of Hunter-Bowen cycle include ~332 Ma intrusion-related gold (IRG) deposits (Kidston: Perkins and Kennedy, 1998: 45), ~345 Ma epithermal gold (e.g. Pajingo and Vera-Nancy: Perkins et al., 1995: 46) and 310-280 Ma skarn and granite-related deposits (Mt Leyshon, Ravenswood, Mt Wright and Red Dome-Mungana: Perkins and Kennedy, 1998) in northern Queensland. These deposits are also a subject of Excursion 2.

A belt extending from northern New South Wales through central Queensland contains epithermal gold deposits hosted by ~290 Ma volcanic rocks (e.g. Cracow: Dong and Zhou, 1996) and a number of small, slightly younger (e.g. Mt Chalmers: ~277 Ma; Crouch, 1999) VHMS deposits, some with advanced argillic alteration assemblages. Lode gold-antimony deposits in northeastern New South Wales appear to be somewhat younger, with ages of ~255 Ma (Ashley et al., 1994).

The final mineralising event of the Hunter-Bowen cycle includes granite-related Sn-W-Mo (e.g. small deposits related to the Mole Granite) and intrusion-related gold (e.g. Timbarra: Mustard, 2001) associated with 245-240 Ma granites in northeastern New South Wales and southeastern Queensland. In addition, epithermal deposits around Gympie (~245 Ma: Cunneen, 1996), southeastern Queenland also appear to be associated with this event.

Outside of the Tasman Orogen, the only other major Paleozoic to Mesozoic mineralising events in Australia were Mississippi Valley-type Zn-Pb deposits of the Lennard Shelf in the Canning Basin (Wallace et al. 2002). These deposits appear to have formed in two events: an early (425-410 Ma: McCracken et al., 1996) event that is inferred to have formed the Admiral Bay deposit (47), and a later event (~357 Ma: Christensen et al., 1995) that is inferred to have formed deposits on the Lennard Shelf. Although these mineralizing events can be related to local tectonic events, their relationship to the overall geodynamic evolution of Australia is unclear.

Conclusions

The metallogenic evolution of Australia is closely linked to its tectonic evolution. Most mineral deposits are associated with the growth of cratonic blocks and their amalgamation. Although mineralising events were widespread through most of geologic time, much of the mineral wealth of Australia formed during four main mineralising epochs: 2710-2620 Ma, 2000-1960 Ma, 1700-1500 Ma and 510-350 Ma. The first epoch involved major lode Au and orthomagmatic Ni-Cu deposits in the Yilgarn Craton that were the consequence of the growth and cratonisation of the Eastern Goldfield Province. The second epoch was associated with the 2000-1960 Ma Glenburgh Orogeny, and possibly the ~1830 Ma Capricorn Orogeny, at which time the Yilgarn and Pilbara Cratons were amalgamed. At this time oxidised hydrothermal fluids expelled during this orogeny upgraded pre-existing banded-iron formation to form iron ore deposits in the Hamersley Basin. The third epoch was most likely the result of convergence along the margins of the NAC and SAC. Deposits of various types are associated with bends in the apparent polar wander path between 1700 and 1500 Ma, suggesting linkages with changes in plate motion. The final epoch, at 510-350 Ma, is related to convergence along the eastern Australian seaboard and can be related to tectonic cycles that formed the Lachlan Orogen. Although these metallogenic epochs produced most of the mineral wealth, mineralisation occurred through most of Australia's geologic history. Some major deposits, such as the Telfer gold deposit, are isolated in time, and new data suggest that global tectonic events, such as the break-up of Rodinia, may be expressed as metallogenic events in Australia.

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***June 21-26**
GOLDSCHMIDT™2009 - "Challenges to Our Volatile Planet" - Davos, Switzerland. Several sessions on ore deposits. Contact: http://www.goldschmidt2009.org/

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Iron Ore 2009, Perth, WA - Contact: Katy Wynn; Telephone: +61 3 9658 6125; Facsimile: +61 3 9662 3662

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10TH BIENNIAL SGA MEETING. Townsville, Australia. http://www.e-sga.org/, www.ees.jcu.edu.au/SGA2009

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7TH INTERNATIONAL MINING GEOLOGY CONFERENCE 2009. Queenstown, New Zealand. The AusIMM Events Department, Phone +61 3 9662 3166, Fax +61 3 9662 3662, E-mail conference@ausimm.com.au, www.ausimm.com

August 30 – September 4
18TH INTERNATIONAL MASS SPECTROMETRY CONFERENCE. Bremen, Germany. http://www.imsc-bremen-2009.de/

September 3-7
AN INTERNATIONAL CONFERENCE ON THE CAMBRIAN EXPLOSION. Banff, Alberta, Canada. http://www.geology.utoronto.ca/facultycaron/Walcott2009.htm

***September 5-9**
MANGANESE IN THE TWENTY-FIRST CENTURY Short Course, SGA co-sponsored, Hotel OÁZIS, Ajka or Veszprém, Hungary - Contact: Márta Polgári Institute for Geochemical Research, Hungarian Academy of Sciences, rodokrozit@gmail.com, +3613193137; mobile: +36209284650

October 5-9
INTERNATIONAL SYMPOSIUM ON THE GEOLOGY OF THE BLACK SEA REGION II. Ankara, Turkey. E-mail uiab@mta.gov.tr, Phone-Fax +90-312-287 91 93 , http://www.mta.gov.tr/

October 18-21
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2010

***February 4-7**
6th INTERNATIONAL DYKE CONFERENCE (IDC) - Varanasi, India. Contact: Prof. Rajesh K. Srivastava; E-mail idcindia2010@yahoo.co.in, http://www.igpetbhu.com/idc6/index.htm

GEOLOGICAL ASSOCIATION OF CANADA AND THE MINERALOGICAL ASSOCIATION OF CANADA (Joint Meeting), (GAC-MAC): GeoCanada 2010, Calgary, Canada - Contact address: website: http://www.halifax2005.ca/

***June 21-24**
11th INTERNATIONAL PLATINUM SYMPOSIUM, Sudbury (Canada), Website: http://11ips.laurentian.ca. Contact: Prof. Dr. Michael Lesher, 11ips@laurentian.ca

August 22-27
20th GENERAL MEETING OF THE INTERNATIONAL MINERALOGICAL ASSOCIATION. Budapest, Hungary. http://www.univie.ac.at/Mineralogie/IMA_2010/

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Report on the XXVII edition of the UNESCO-SEG-SGA Latin American Metallogeny Course

La Paz, Bolivia, August 18–29, 2008

Fernando Barra, International coordinator of the 2008 edition

Department of Geosciences, The University of Arizona, Tucson, AZ, USA

The UNESCO-SEG-SGA Latin America Metallogeny Course was held in La Paz, Bolivia from 18-29 August, 2008. This year the course was hosted by the Universidad Privada Boliviana and organized by Osvaldo Arce (EMUSA) and Fernando Barra (University of Arizona, USA) as International Coordinator. The purpose of these Latin America courses is to provide an opportunity for young geologists working on academia or in the mining industry to update their skills and knowledge on mineral deposits with leading researchers in the field.

The 2008 course comprised two parts: a series of lectures which provided participants with a review on the geochemistry of hydrothermal processes (Mark Reed, University of Oregon), an update on the use of fluid inclusions (Larryn Diamond, University of Bern) and new applications of radiogenic isotopes and geochronology in the study of mineral deposits (Fernando Barra, University of Arizona). Following lectures focused on the geology and genesis of Sn/W and diamond deposits (Bernd Lehmann, Technical University of Clausthal), skarns and IOCG (Fernando Tornos, Instituto Geologico Minero de España), epithermal (Antonio Arribas, Newmont Mining Corp.) and orogenic gold deposits (Larryn Diamond). A full day of lectures was devoted to mineral deposits in Bolivia and entirely presented by local instructors (Michael Biste, consultant; James McNamee consultant; Oscar Ballivián, Universidad Mayor de San Andrés; Ramiro Mattos, Universidad Mayor de San Andrés; Eddy Escalante, consultant; and Osvaldo Arce, Empresa Minera Unificada S.A.). The theory part was followed by a week-long field trip to some of the most important ore deposits of Bolivia. Sites visited included the Kellhuani tin district in the Cordillera Real, the "red bed" sediment-hosted stratabound Coro Coro deposit, the Kori Chaca gold deposit, the pollymetalic Bolivar mine, the epithermal deposit of San Cristobal, the Salar de Uyuni world's largest salt flat with more than 10,500 km^2 and last but not least the world's largest silver deposit, Cerro Rico de Potosi. Potosi, located at 4090 m above sea level is probably the highest city on Earth and was declared by Unesco as a World Heritage Site in 1987.

We received over 150 applications but the theory course was limited to 75 participants and the field trip to 35. Of the 75 participants 21 were granted scholarships. Course participants were from Argentina, Peru, Colombia, Mexico, Brasil, Costa Rica and Bolivia. About 80% of participants were from mining companies, which reflects the high interest of young geologists working in the mining industry in updating their knowledge of mineral deposits. On the other hand, the lower participation of geologists working in academia reflects the current status of the field, with fewer young geologists pursuing graduate studies or a career in academia.

The course is the most prestigious and important in the field of Economic Geology that is offered in Latin America. The continued success of the course is based on the increasing number of geologists, from both academia and industry, interested in learning and discussing different aspects of ore formation from leading researchers in the field. This course could not be possible without these researchers, who provide their time and knowledge, and the support of Unesco, SGA, SEG and mining companies.

The next edition of the course will be held in Belo Horizonte, Minas Gerais, Brazil and will be organized by Francisco Javier Rios (CDTN) and Carlos A. Rosiére (IGC-UFMG), and Fernando Tornos as International Coordinator. Further information can be found at <http://www.unige.ch/sciences/terre/mineral/seminars/latinometal.html>

International instructors of the 2008 edition of the course with typical Bolivian hats. From left to right: Larryn Diamond, Fernando Barra, Fernando Tornos, Bernd Lehmann, Mark Reed, Antonio Arribas.

Course participants pose for a group photo at the Universidad Privada Boliviana.

A group of participants to the field trip prepare to enter the Bolivar mine.

Hydrothermal Processes

F. Pirajno, Geological Survey of Western Australia, Perth, Australia

Hydrothermal processes on Earth have played an important role in the evolution of our planet. These processes link the lithosphere, hydrosphere and biosphere in continuously evolving dynamic systems.

Terrestrial hydrothermal processes have been active since water condensed to form the hydrosphere, most probably from about 4.4 Ga. The circulation of hot aqueous solutions, or hydrothermal systems, at and below the Earth's surface, is driven by magmatic heat. Hydrothermal systems form beneath the oceans (e. g. spreading centres, oceanic plateaux), in lakes, intracontinental rifts, continental margins and magmatic arcs. Hydrothermal fluids can be juvenile-magmatic or derived from seawater, metamorphic, meteoric, connate waters or a mix of two or more of these.

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SGA

Society for Geology Applied to Mineral Deposits (www.e-sga.org)

MEMBERSHIP APPLICATION FORM

I would like to become a member of the **Society for Geology Applied to Mineral Deposits** and to receive my personal copy of **Mineralium Deposita**. Membership fees will be due after acceptance of the membership application by the SGA Council.

- Type or Print -

Name / Corporation	
First name	
Title	
Mailing address	
Phone	
Fax	
e-mail	
Academic degrees	

Check only one of the two boxes below

☐ I want to receive Mineralium Deposita and membership privileges for the current calendar year including back issues

☐ I want to receive Mineralium Deposita and membership privileges for the next calendar year

Select your Membership Dues

☐ 75.00 EUR Regular Member (Print+Internet **Mineralium Deposita** and **SGA News**)

☐ 60.00 EUR Regular Member (Internet only **Mineralium Deposita** and **SGA News**)

☐ 10.00 EUR Student Member (Internet only **Mineralium Deposita** and **SGA News**, max. 4 years, up to Ph.D.- certificate required)

☐ 60.00 EUR Senior Member (Print+Internet **Mineralium Deposita** and **SGA News**, after retirement - certificate required)

☐ 300.00 EUR Corporate Member (includes 3 copies of **Mineralium Deposita**) (for industry only, no academic)

If my application is approved by the SGA Council, I authorize the "Society for Geology Applied to Mineral Deposits" to charge the above amount (please tick) to my credit card:

☐ VISA ☐ MASTERCARD/EUROCARD ☐ AMERICAN EXPRESS

Card No: _____ **Expiry date (MM/YY):** _____

Signature . _____ Place and date _____

(if you do not intend to pay by credit card, an invoice will be issued after acceptance of your application)

Sponsor (SGA member):

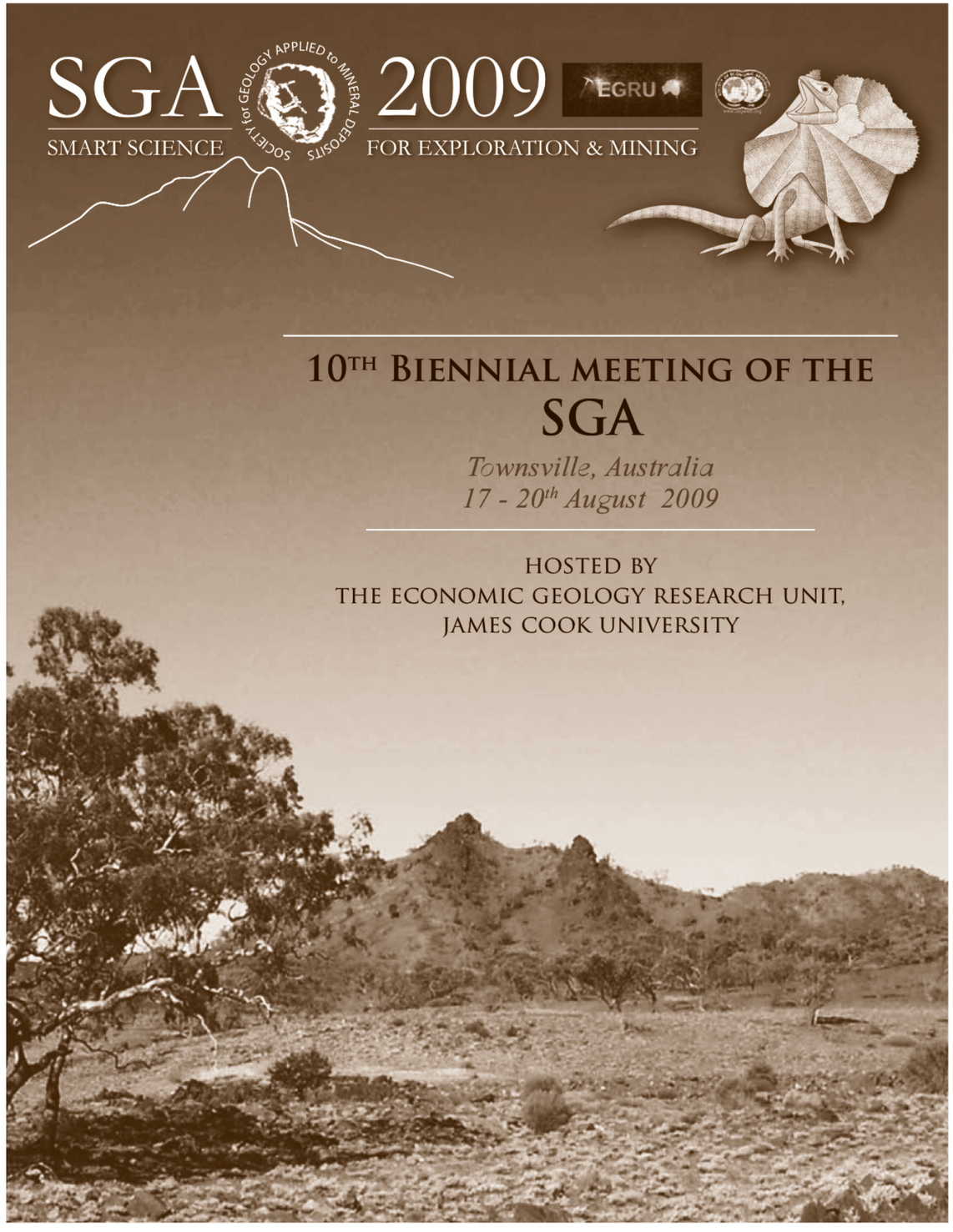
Name Place Date Signature

1. _____

Send the Membership Application Form to:

Dr. Jan Pasava
SGA Executive Secretary
Czech Geological Survey
Klárov 131/3
CZ-118 21 Praha 1
CZECH REPUBLIC

Phone: ++(420)-2-51085506
Fax: ++(420)-2-51818748
E-mail: secretary@e-sga.org



CODES UTAS Centre for EXPLORATION TARGETING THE UNIVERSITY OF WESTERN AUSTRALIA Achieving International Excellence JCU JAMES COOK UNIVERSITY planetearth Earth Sciences for Society

SGA 2009 EGRU
SMART SCIENCE FOR EXPLORATION & MINING

The Society for Geology Applied to Mineral Deposits (SGA) and the Economic Geology Research Unit (EGRU) at James Cook University, in association with the Society of Economic Geologists (SEG), are delighted to invite all their members and others interested in economic geology to the

10TH BIENNIAL MEETING OF THE SGA

Townsville, Australia
17 - 20th August 2009

THE TOWNSVILLE ENTERTAINMENT & CONVENTION CENTRE AND JUPITERS HOTEL & CASINO
TOWNSVILLE QUEENSLAND, AUSTRALIA

PROGRAM

Thematic Sessions

(A) Ore-Forming Processes

1. Mineral systems and large-scale exploration targeting
   Paul Roberts (CSIRO), Cam McCuaig (CET), James Cleverley (CSIRO)
2. Magmatic ores and their petrogenetic/tectonic setting
   Steve Beresford (CET), John Mavrogenes (ANU), Marco Fiorentni (CET)
3. Hydrothermal processes in ore-forming systems
   Tony Christie (IGNS), Poul Embso (USGS)
4. Dating ore deposits: geological and geochronological problems
   Massimo Chiradia (Uni. Geneve), Ken Hickey (UBC)
5. Metal remobilization in the formation of hypogene and supergene ore deposits
   Gregor Borg (Uni. Halle), Paulo Vasconcelos (UQ)

(B) Specific Mineral Systems

1. Golden controversies: classification of epigenetic gold deposits
   Craig Hart (UBC), 2nd Convenor TBC
2. Sediment- and volcanic-hosted Cu, Cu-Zn and Pb-Zn deposits
   Rod Allen (LUT), Jan Peter (GSC)
3. Understanding porphyry-epithermal systems
   Robert Moritz (Uni. Geneve), Eduardo Campos (UCN Chile)
4. The origin of enriched iron and manganese ore deposits
   Steffen Hageman (UWA), Carlos Rosiere (UFMG), Thomas Angerer (CET)
5. The nature and origin of uranium deposits
   Frank Bierlein (AFMECO), Christian Marignac (Uni. Nancy)
6. Genesis of iron oxide-copper-gold deposits
   Mike Porter (Portergeo), Fernando Tornos (IGME), Louise Corriveau (GSC)
7. Diamonds: Where are they and why?
   Simon Richards(JCU) 2nd Convenor TBC

(C) New and Frontier Areas

1. Applied mineralogy (metallurgy, exploration, environmental management and remediation)
   Steve Walters (CODES), Julie Hunt (CODES), Joel Brugger (SA Museum)
2. Non traditional geochemical and microchemical methods: applications in ore genesis and exploration
   Sarah Gleeson (Uni Alberta), 2nd Convenor TBC
3. Mining and the environment: issues and solutions
   Bernd Lottermoser (JCU), Dave Craw (Uni. Otago)
4. Finding resources under cover: new geophysical and imaging techniques for exploration
   David Giles (U Adelaide), Mark Gettings (USGS)
5. Structual controls on mineralization, conceptual targeting and prospectivity/endowment analysis
   Tom Blenkinsop (JCU), Oliver Kreuzer (Regalpoint Exploration), Alok Porwal (CET)
6. Numerical simulations of hydrothermal systems
   John McLellan (JCU), Al Hofstra (USGS)
7. Three dimensional modelling
   Leonardo Feltrin (JCU), Laurant Allieres (Monash Uni)
8. Tectonic analysis and history of terrains as indicators of metallogenic fertility
   Par Wiehed (LUT), Richard Blewett (GA)

(D) General Session

New developments in mineral deposits geology

David Groves, *SGA President*

'What is special about giant mineral systems'

SGA Plenary Session

Self-organized systems, ore formation and mineral system science ..... Jon Hronsky
Fluid inclusions and numerical modelling of magmatic-hydrothermal systems ..... Chris Heinrich
PGE ore deposit controversies ..... Jim Mungall
Lithospheric analysis and mineral systems ..... Sue O'Reilly
Metallogenic evolution with time ..... Rich Goldfarb
Mesozonal mineralization in the making ..... Rick Sibson
Magma fertility and mineralization ..... David Cooke

SEG Plenary Session

Outlook for the mining industry for the next 5 years ..... John Thompson
New advances in exploration techniques applied to uranium and IOCG's ..... Rick Valenta
Gold solubility, transport and deposition in active epithermal systems ..... Stuart Simmons
IOCG's, porphyries and alkali alteration in the American Cordilleras ..... Mark Barton

Workshops and Short Courses

1. Ore textures and breccias
2. Exploring for IOCG (U) deposits
3. Hands on workshop in laser-based microanalysis
4. Exploration for resources under cover
5. Hyperspectral imaging: applications to exploration
6. Sediment-hosted gold deposits
7. Porphyry and epithermal deposits
8. Uranium ore deposits
9. Mineral Systems: concepts to practical outcomes

Field Trips

1. Mt Isa/Cloncurry districts NW Queensland
2. North Queensland gold & base metal deposits
3. Iron ore deposits, Hamersley & Yilgarn Western Australia
4. Yilgarn Craton, Western Australia; Nickel & Gold
5. Epithermal gold deposits & active hot springs, New Zealand
6. Ore deposits of Papua New Guinea
7. Olympic Dam-Mt Painter Cu-Au-U, South Australia

Registration Fees	Early Bird (before 31/05/09)	Late (after 31/05/09)
Member SGA, EGRU, SEG	$ 825.00	$ 935.00
Non-Member	$ 935.00	$1045.00
Student Member SGA & SEG	$ 375.00	$ 425.00
Student Member SGA or SEG	$ 400.00	$ 450.00
Student Non-Member	$ 450.00	$ 500.00
2 Days Only	$ 660.00	$ 715.00
Accompanying Person	$ 110.00	$ 110.00

SGA 2009 SMART SCIENCE FOR EXPLORATION & MINING

Students

Attractive incentives are being offered to students to encourage their participation in SGA 2009. These incentives include:

- Discounted registration fees
- Industry sponsored student event
- Student poster session
- Sponsorship packages for field trips, workshops or travel costs
- $1000.00AUD cash prize will be presented for the best student presentation or poster

An application form for student sponsorship is available at http://sga2009.jcu.edu.au

Sponsorship and Exhibitor Packages

On behalf of the Organising Committee, we invite you to consider one of our sponsorship packages available at the 10th Biennial meeting of the SGA. We have a strong and specific commitment to ensure the best possible outcomes regarding booth placement and visibility, specific sponsoring organisation benefits including branding, advertising and registration subsidies, and the coordination of social activities

Full details of the Sponsorship and Exhibitor Packages can be viewed at http://sga2009.jcu.edu.au.

Student Sponsorship

Sponsorship support for students to attend the SGA Meeting is being sought to encourage as many students as possible to attend. Various levels of student sponsorship are available. Please see the website for full details http://sga2009.jcu.edu.au

KEY DATES	
January 2009	**Registration opens**
16 January 2009	Submission of abstracts available via website
16 February 2009	Abstract submission deadline
16 February 2009	Applications close for student support
16 March 2009	Editorial decisions from convenors
16 April 2009	Final revised abstracts from authors due
24 May 2009	Notification of final acceptance or rejection of abstract
31 May 2009	Deadline for early bird registration
31 May 2009	Last day to receive a full refund of registration
15 June 2009	Last day to receive partial refund for cancellation
7 August 2009	Pre-meeting workshops and field trips begin

Convenors

Patrick Williams - patrick.williams@jcu.edu.au
Nick Oliver - nick.oliver@jcu.edu.au
Brian Rusk - brian.rusk@jcu.edu.au

Website: http://sga2009.jcu.edu.au
Email: sga2009@jcu.edu.au

Conference Organisers Office

Antoinette Woods
Tailored Statements
PO Box 298 HYDE PARK, QLD 4812
AUSTRALIA
Telephone: +61 7 4725 5019
Facsimile: +61 7 4725 0175
info@tailoredstatements.com.au

All information contained in this Circular is correct as of November 2008

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