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

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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...
The XIII Congreso Latinoamericano de Geología and the XIV Congresso Peruano de Geologia, organized by the Sociedad Geologica 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 vice-president 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, Ucchuaqucha, 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 Peru. 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 - Colquipis, Perdido, 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 Maria Teresa, we were introduced to the geology of the mines by Ings. Alejandro Trujillos (MILPO) and Edgar Pichardo (Minera Colquisit) 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 Tomos.

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 convincing 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.

SGA booth at the XIII Latin American Geological Congress Lima Peru 29 September–3 October 2008
Fernando Tornos, SGA Vice-President

Fernando Tornos in front of the SGA booth explaining the benefits of becoming SGA member to two students
Massimo Chiaradia (left), Gregor Borg (middle) and Urs Schaltegger (right) setting up the SGA booth.

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Manuscripts should be sent by e-mail using Microsoft Word for text and .jpg or .tif formats for pictures and figures (the latter must be in grey level tones, not colour!). Please always send a paper copy and indicate the format you are using.

**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:

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**FOR SGA 2009 ELECTION**

**CALL FOR CANDIDATES**

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.
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 cry-
The report was presented by P. Williams and R. Duckworth. SGAagina (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 will have to be submitted to Council for the final vote in early 2009.

Policy for SGA sponsorship of meetings and discussion of biennial plan to handle requests for SGA sponsorship

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 SGA’s expectations for the conference detailed in the Guidelines for Organizing a SGA Biennial Meeting.

Any other business

Council agreed to add P. Williams to the list of corporate sponsors that donated money 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 and 2009 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 encouragement of SGA 2009 in Townsville – (R. Duckworth from EGRU, P. Williams)

Summarized of the 5 main events in 2008 (J. Palava)

The summary was presented by J. Palava 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, in the preparation of the Turkish meeting, the effort 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’s Council from SGA website.

Changes to SGA Statutes – Council vote (J. Palava)

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. Elu, J. Palava)

Following the approved SGA Membership Drive suggested by D. Groves and supervised by P. Elu, the report on new membership forms. The SGA 2008 membership development was an EGRU.org event, 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.

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Strategy for biennial SGA workshops from 2010 (D. Groves)

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The SG website

Georges Beaudoin, Chief Editor SG website
Université Laval, Québec, Canada, georges.beaudoin@uqal.ca

http://www.e-sga.org

Welcome to the SG

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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).
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, through-going 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; 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.

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).

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

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

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). The Capricorn Orogen includes important volcano-sedimentary and sedimentary basins, containing the Magellan nonsulphide Pb deposit in the Allanby 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). 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.

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Broken Hill type deposits in the eastern part of the NAC are one subject of excursion 1, "Mt Isac Chatclourty districts, New South Wales (see page 27)." Although the major later Paleoproterozoic deposits are temporally associated with bends in the apparent polar wander path (Fig. 4; Idiurnu, 2000), suggesting that the Neoproterozoic orogenic belts of the NAC may have come 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 result from the accretion of the Warramoo Province onto the southern margin of the Aileron Province (Scrimgeour et al., 2005), coincided with the formation of the HYC (30 Mt Zn + Pb: 26) and the undated Tropicana-Havana lode gold event (~440 Ma in the Seventy Mile Range (Crawford et al., 2002). These deposits appear to have formed in an arc that overlaps in time with the Benambran orogeny (Glen, 1995; Champion et al., in press), which marked the end of the Ta-
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The final mineralising event of the Hun-
nel-Burren cycle includes granite-related Cu-Au (40) and Zn-Pb (41) deposits in the Canning Basin (Wallace et al., 1981 and King Island (44): Seymour et al., 1992; Huston and Kamprad, 2001). These deposits appear to have formed in an arc that overlaps in time with the Benambran orogeny (Glen, 1995; Champion et al., in press), which marked the end of the Ta-
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Conclusions

The metallogenic evolution of Australia is closely linked to its tectonic evolution. Most mineral deposits are associated with the growth of cratons, 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 metallogenic epochs: 2710-2620 Ma, 2000-1960 Ma, 1700-1500 Ma and 510-350 Ma. The first epoch involved major mafic and orthomagmatic Ni-Cu deposits in the Yilgarn Craton, and possibly the ~1830 Ma Capricorn Orogen, at which time the Yilgarn and Pilbara Cratons were amalgamated. 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 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.

Acknowledgements

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References


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SGA news

SGA news
of mineralization in the Archean North Peninsula Terrian, Western Australia. Economic Geology 97, 733-756.


* marks a new entry


September 3-7 AN INTERNATIONAL CONFERENCE ON THE GEOLOGY OF CANADA’S PRECAMBRIAN PLATEAU, Iona, Manitoba, Canada. http://www.geology.utoronto.ca/faculty/caron/Walict09/2009

September 5-9 MANGANESE IN THE TWENTY-FIRST CENTURY - Short Course, SGA cosponsored, Hotel GAZİ, Aka ve Vezneyp, İstanbul - Contact: Mátia Polgári Institute for Geochemistry, Hungarian Academy of Sciences, rodokusz@gmail.com, +3613191317; mobile: +36202984860

September 5-9 24th INTERNATIONAL APPLIED GEODEMYSTERY SYMPOSIUM 2009, University of New Brunswick, Fredericton, Brande, Canada - Contact: http://www.ubnb.ca/conferences/SAGDS2009/

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

October 18-21 GEOLOGICAL SOCIETY OF AMERICA: 121st ANNUAL MEETING, Portland, Oregon, USA - Contact address: GSA Meetings Dept., P.O. Box 9140, Boulder, CO 80301-9140, USA; phone: +1 303 447 2020; fax: +1 303 447 1133; e-mail: meetings@geosociety.org; website: http://www.geosociety.org/meetings/index.htm

October 25-November 3 NATIONAL MINERALOGICAL ASSOCIATION (Joint Meeting), (GAC-MAC): GeoCanada 2010, Calgary, Canada - Contact address: website: http://www.halifa2005.ca/

November 26-27 20th GENERAL MEETING OF THE INTER-NATIONAL PLATINUM SYMPOSIUM, Sudbury (Canada), Website: http://11ips.sudbury.ca. Contact: Prof. Dr. Michael Lesher, e-mail: 11ips@laurentian.ca

October 31-November 3 GEOLOGICAL SOCIETY OF AMERICA: 122 ANNUAL MEETING, Denver, Colorado, USA - Contact address: GSA Meetings Department, P.O. Box 9140, Boulder, CO 80301-9140, USA; phone: +1 303 447 2020; fax: +1 303 447 0688; e-mail: meetings@geosociety.org; website: http://www.geosociety.org/meetings/index.htm

November 9-12 GEOLOGICAL SOCIETY OF AMERICA: 123rd Annual Meeting, Minneapolis, Minnesota, USA. GSA Meetings Department, P.O. Box 9140, Boulder, CO 80301-9140, USA; phone: +1 303 447 2020; fax: +1 303 447 0688, E-mail meetings@geosociety.org; website: http://www.geosociety.org/meetings/index.htm

* holds an entry
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 Espa’a), 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 McNamie, 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 poly metallic Bolivar mine, the epithermal deposit of San Cristobal, the Salar de Uyuni world’s largest salt flat with more than 10,500 km2 and last but not least the world’s largest silver deposit, Cerro Rico de Potosí. Potosí, 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.

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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. Rosiérre (IGC-UFMG), and Fernando Tornos as International Coordinator. Further information can be found at <http://www.unige.ch/sciences/terre/mineral/seminars/latinometal.html>
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. The interaction of hydrothermal fluids with wallrocks and/or the hydrosphere and changes in their composition through time and space, contribute to the formation of a wide range of mineral deposit types and associated wallrock alteration.

► Primitive life in terrestrial hydrothermal systems ► Analogues of terrestrial hydrothermal systems on other planets ► Role of meteorite impacts on inception of hydrothermal systems and life ► Up-to-date information on hydrothermal systems and processes ► Search for life on extraterrestrial planetary bodies

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Stable Isotope Geochemistry
J. Hoefs, University of Göttingen, Germany

Stable Isotope Geochemistry is an introduction to the use of stable isotopes in the geosciences. It is subdivided into three parts: theoretical and experimental principles; fractionation processes of light and heavy elements; the natural variations of geologically important reservoirs. Since the application of stable isotopes to earth sciences has grown in the last few years, a new edition appears necessary. Recent progress in analysing the rare isotopes of certain elements for instance allow the distinction between mass-dependent and mass-independent fractionations. Special emphasis has been given to the growing field of “heavy” elements. Many new references have been added, which will enable quick access to recent literature. For students and scientists alike the book will be a primary source of information with regard to how and where stable isotopes can be used to solve geological problems.

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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.

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Send the Membership Application Form to:

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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
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
Mesoscale mineralization in the making…………………………… Rick Silson
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

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

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<th>Category</th>
<th>Early Bird (before 31/05/09)</th>
<th>Late (after 31/05/09)</th>
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<tr>
<td>Member SGA, EGRU, SEG</td>
<td>$ 825.00</td>
<td>$ 935.00</td>
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<tr>
<td>Non-Member</td>
<td>$ 935.00</td>
<td>$1045.00</td>
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<tr>
<td>Student Member SGA &amp; SEG</td>
<td>$ 375.00</td>
<td>$ 425.00</td>
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<tr>
<td>Student Member SGA or SEG</td>
<td>$ 400.00</td>
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<td>Student Non-Member</td>
<td>$ 450.00</td>
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<td>2 Days Only</td>
<td>$ 660.00</td>
<td>$ 715.00</td>
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<td>Accompanying Person</td>
<td>$ 110.00</td>
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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
- $1000.00 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

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<tr>
<th>KEY DATES</th>
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<td>January 2009</td>
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<td>15 June 2009</td>
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<td>7 August 2009</td>
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All information contained in this Circular is correct as of November 2008

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