Australian Institute of Geoscientists

AIG NEWS

Quarterly Newsletter No 93 August 2008

CONTINENTAL EXPANSION — AUSTRALIA GROWS!

UN Confirms Australia's Extended Marine Jurisdiction — Potential Bonanza of Oil and Gas Riches

Australia's submission for jurisdiction over an additional 2.5 million square kilometres of seabed has been confirmed by the United Nations Commission on the Limits of the Continental Shelf.

The Commission has confirmed the location of the outer limit of Australia's continental shelf in nine distinct marine regions, which entitles Australia to large areas of continental shelf beyond 200 nautical miles.

This decision means Australia now has jurisdiction over an extra 2.5 million square kilometres of continental shelf, which is almost five times the size of France, almost ten times the size of New Zealand, and approximately the same size as Western Australia.

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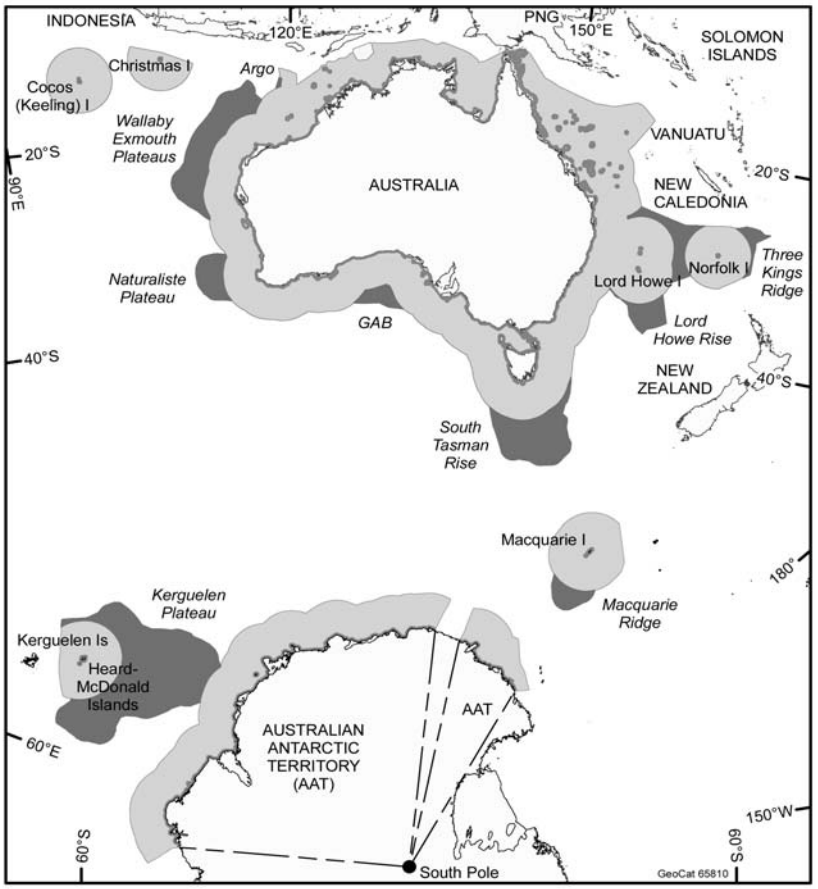

AUSTRALIA'S CONTINENTAL SHELF CONFIRMED BY THE COMMISSION ON THE LIMITS OF THE CONTINENTAL SHELF

Territorial sea and internal waters

Areas of marine jurisdiction within 200 M of Australia and its external territories

Area of Australia's continental shelf beyond 200 M as confirmed by the Commission on the Limits of the Continental Shelf

Joint Petroleum Development Area under Timor Sea Treaty 2002

Note: The areas of continental shelf depicted to the north-west of Australia reflect the terms of the 1997 maritime boundary treaty with Indonesia which has not yet entered into force.

1 nautical mile (M) = 1852m

INSIDE THIS AIG NEWS:

Continental Expansion — Australia Grows!

Cont. from Page 1

In these areas, Australia has exclusive rights to what exists on the seabed, including oil, gas and biological resources.

Under the 1982 United Nations Convention on the Law of the Sea, the continental shelf extends at least 200 nautical miles from Australia's coastline.

Australia is also entitled to the submerged prolongation of its landmass extending beyond 200 nautical miles (the so-called extended continental shelf), to limits defined in the 1982 Convention.

To confirm Australia's entitlement, Geoscience Australia analysed an enormous amount of new data gathered on 17 marine surveys conducted over eight years in some of the most remote and inhospitable parts of the world's oceans. ▲▲

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From the Editor

THIS EDITION OF AIG News contains a short summary of the AESC 2008 which was attended by up to 1000 geoscientists, though some of us in the industry had to continue slogging it out in the field.

The third instalment of the *Stratigraphic Controls on Structures and Mineralisation in Central Victoria* is in this issue.

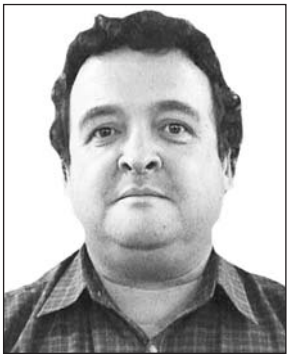
It seems that some areas of climate science are starting to notice the possible connection between geophysical electrical and weather, and Swedish climate scientist Hans Jelbring reviews an interesting paper by Brian Tinsley — *Macro Cosmos meets Micro Cosmos.*

Then the recent discovery of an electromagnetic connection between the ionosphere and earthquakes suggests that maybe electricity has a far large role in earth processes than hitherto thought possible.

An interesting discovery of the effects of an exploding asteroid 12,900 years ago refreshed my memory of a paper published in the New Concepts of Global Tectonics Newsletter concerning the geological consequences of large meteoric bodies approaching the earth — perhaps there is a connection?

Other bits of news include abiotic hydrocarbons, a US-inspired mega merger between the USGS and the NOAA, a new test to put the "Geo" back into geostatistics, and finally lost members are listed at the end — those who know anyone on the list please ask them to update their address details.

From Your President



I'M SURE THAT ALL members will join me in congratulating Mike Smith, the inaugural recipient of AIG's Distinguished Service Medal. Mike was presented with his medal by Rick Rogerson, AIG Vice President, at the Australian Geological Convention held in Perth during August. Mike is the current Chairman of the Australian Geoscience Council, Chairman of the AIG Registration Board, a past AIG President and long-serving Councillor and a past President of the Australian Society of Exploration Geophysicists. The Medal recognises Mike's years of committed service to AIG, the Australian geoscience community more generally and his particular contribution to the recognition and standing of the geoscience profession in Australia. Congratulations Mike.

The Australian Geological Convention, held in conjunction with the Geological Society of Australia, was attended by almost 1,000 geoscientists from throughout Australia and overseas and has been universally described as a very successful convention. The convention's exploration and mining theme, one of a series in a packed technical programme, represented the largest resource geoscience meeting in Australia this year. One of the most beneficial and interesting aspects of these conventions is the unique opportunity they provide for Australian geoscientists to attend a truly multidisciplinary technical meeting where new developments in all aspects of geosciences can be presented and discussed.

Almost 200 Australian geoscientists at the time of writing this report are attending the 33rd International Geological Congress in Oslo, Norway. There are almost 7,000 geoscientists from all around the world attending the congress which, again, provides an opportunity to discuss a wide range of technical and professional issues. Representatives for the 34th IGC, to be held in Brisbane in 2012, are in Oslo, getting first hand experience of the scale of the congress and experience that will help to ensure the success of the congress in Brisbane. The congress has attracted considerable public attention in Norway. Australian geoscience stands to reap substantial benefits from similar public attention to the Brisbane congress in 2012. The organisation of the next congress will involve Geoscience Australia, all State geological surveys, geological societies and professional institutes, whose participation is being coordinated through the Australian Geoscience Council. News regarding the organisation of the Brisbane congress will appear regularly in AIG News and on the web site, during the lead-up to 2012. The Australian stand at the congress in Norway has received considerable attention from delegates, and the Australian team will deserve a good rest when they get home after the hard work they have put into promoting the congress in Norway.

The Drilling for Geology conference, being presented by Queensland Branch in Brisbane in October, is another multidisciplinary event where geoscientists working in different sectors will have the opportunity to present and discuss ideas and practical techniques.

The American Geological Institute (AGI) convened a very interesting workshop during the IGC, discussing employment opportunities and the anticipated demand for geoscientists throughout the world. The workshop presentations highlighted a number of factors affecting the geoscience profession throughout the world. Some of the more significant of these included:

- there are marked differences in the roles filled by geoscientists in different countries throughout the world. For example, mineral exploration and mining employs only five percent of geoscientists in France (and a similarly low proportion in other European countries). In France, approximately 50% of geoscientists work in the public sector, including education, while a further 25 % work in the oil and gas industry. This is markedly different to the situation in Australia where some 70% of geoscientists are employed in exploration and mining.
- emergent fields of geoscientific practice: carbon sequestration and other climate change related fields; geothermal energy, and nuclear waste management are predicted by a detailed study prepared by BRGM to provide the greatest opportunities for employment growth.
- the resources industries are also predicted by BRGM to be a source of increasing employment opportunities for geoscientists until at least 2020.

Several participants in the workshop, representing both public and private sector employers outlined a set of desirable attributes for geoscientists:

- personal integrity;
- a command of English (interestingly, some French universities are considering moving to teaching geoscience in English rather than French in order to attract and meet the needs of foreign students);
- intellectual capacity and a mastery of scientific method, including an ability to objectively integrate and interpret data from multiple sources of data (mapping was proposed as the most effective means of fostering the development of these skills);
- a mastery of fundamental Earth processes;
- cultural adaptability, including a willingness to work away from home in different cultural settings; and,
- well developed personnel and project management, quality assurance, economic analysis and reporting skills.

University geoscience departments throughout the world are suffering from a series of common threats including:

- funding constraints;
- inappropriate metrics used to measure geoscience teaching effectiveness;
- staff attrition and a difficulty attracting new staff due to salaries that are uncompetitive with industry;
- changes in student interests, away from fundamental geology, energy and mining towards environmental sciences; and,
- a decreased ability to support supervised field skills development by students.

These issues are shared by Australian geoscience departments.

The USGS has an interesting programme, EDMAP, now in its twelfth year, where the USGS funds (on a dollar for dollar basis

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AIG Service Award for Mike Smith

THE RECIPIENT of the first AIG Service Award is Dr Mike Smith. The medal was presented to Mike by Rick Rogerson on behalf of the Council during a plenary session of the Australian Earth Sciences Convention in Perth.

The award, a gold medal, is for outstanding service to AIG. It was conceived to honour those AIG members who have gone the extra yard for AIG and/or the geoscience profession. In making this award, the AIG Council was deeply impressed by Mike's contributions to both AIG's corporate objectives and to the geoscience profession more widely.

Responding to the presentation, Mike stated that he had discovered that one criterion for the AIG Service Award is the ability of the recipient to collect the medal in person — it is not intended as a posthumous recognition. Mike learned this when he informed Rick Rogerson that in fact he was not the proper person to be awarded the inaugural AIG Service Medal, and that the proper person was Ken Glasson, the co-founder of the Australian Institute of Geoscientists. Ken was a lecturer in Economic Geology at Sydney University from 1956 to 1967 and a consultant, chief geologist and technical director in the mining industry. Ken passed away on 27 November 1994, and his funeral at Minnamurra south of Sydney was attended by a large number of geoscientists, reflecting widespread respect for his achievements.

Mike explained that during the 1970s, Australian experienced a dramatic boom in nickel exploration (remember the Poseidon affair), as well as strong investment in the search for VHMS, porphyry copper and uranium deposits. Ken Glasson led a move to create a body to establish professional standards and a code of ethics for geoscientists[1]. The initial concept was to create a professional division of the Geological Society of Australia, but ultimately the decision was taken to form the Australian Institute of Geoscientists[2]. Ken co-authored the constitution of the new body and its code of ethics and was elected as the first president of the AIG in 1982, continuing to serve as AIG President for the next five consecutive years.

Ken then continued to participate very actively in the evolution and development of the AIG by serving on the national executive of the AIG for the eight years from 1987 up to his death in 1994. The last three years were the period when Mike Smith held the position of AIG President, and Mike stated that Ken was an excellent mentor to himself and to other AIG leaders. Ken constantly reminded Mike of the purpose of the AIG, and the reasons why a professional society was different to a leaned scientific society. The fact that the AIG was established from considerations originating within the GSA is very relevant to the current discussions between the executives of the AIG and the GSA concerning a possible merger between the two bodies.

Mike was elected to the AIG Council in 1992, and was President from 1993 to 1996. During his Presidency he led the implementation of the Registered Professional Geoscientist scheme that was finally approved in late 1996. With others on the AIG Council, he also pushed very strongly to widen the number of States represented on Council which until the mid 1990s had been dominated by NSW.

On a lighter note, he was also instrumental in designing the thin, early 1990s style AIG neck-tie.

Mike subsequently went on to serve 11 years on the AIG Council and to this day chairs AIG's Registration Board that considers applications for Registered Professional Geoscientist status. This involves a very rigorous vetting process marked by multiple peer-reviews that ensure only the highest quality candidates are admitted to the scheme.

Mike Smith (right) receiving the AIG Service Award from Rick Rogerson
Photo: Clark Rodda of Festival City Photography

Mike, as a geophysicist, is also an active member of the Australian Society of Exploration Geophysicists (ASEG) in which he has served as Treasurer, Vice President and President.

More recently, he has represented AIG and the ASEG on the Australian Geoscience Council and in mid-2002, was elected as Chairman of the AGC. Subsequently, Mike was President of AGC from 2004 to 2006. He has served as the Geoscience Representative on the Board of the Federation of Australian Scientific and Technological Societies for several years, and later as Treasurer for one and a half years. Currently, he is serving another term as Chairman of AGC.

In concluding his response, Mike stated that his activities in various geoscience societies were strongly motivated by his association with those founding fathers of the AIG. He felt hugely honoured by the award of the inaugural AIG Service Medal, and expressed sincere thanks to the selection committee and the Council of the AIG.

Mike is a very worthy first recipient of the AIG Service Award, setting a very high bar for future nominees. ▲▲

Rick Rogerson and Wendy Corbett

1 Ken Glasson was strongly supported by the GSA President of the day Dr. A.F. Trendall, as well as C.L. Adamson, L Ingall, K. Warner, D. Probert, K Mosher and others.

2. The AIG was incorporated on 20 October 1981.

From Your President

Cont. from Page 3

with universities) mapping projects by both undergraduate and postgraduate students with close academic supervision that contribute to the preparation of detailed geological maps. EDMAP is part of a broader collaborative effort between USGS and State geological surveys, the National Cooperative Geological Mapping Program (NCGMP), established by an Act of Congress in 1990 in response to only 20 % of the USA being covered by detailed geological maps in 1990. The EDMAP programmed has helped to provide 750 students with valuable field experience since its inception, with some early participants now in academic positions themselves and submitting project proposals for their own students.

One of the most concerning outcomes of the workshop is the developing gap between demand and availability of geoscience skills that will be felt most acutely by teaching institutions and the public sector but also has wider implications.

You will be aware from recent issues of AIG News that geoscience education has been one of AIG's high priority issues for the past several years. Preparing AIG for the broader challenges faced by geosciences, particularly in Australia, will be a subject to be addressed in a revision of AIG's strategic plan. This will be one of the main tasks facing the AIG Council during the coming twelve months. Input to the plan from members is keenly sought. Suggestions for topics to be addressed and ideas on issues affecting our profession may be forwarded to the Secretariat in Perth or by email to president@aig.org.au

Andrew Waltho

Stratigraphic Controls on Structures and Mineralisation in Central Victoria 3: Fosterville

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S. P. Hitchman, Fosterville Gold Mine
K. J. Allwood, Geomodelling Pty Ltd

Abstract

This is the third in a series of papers discussing the stratigraphic controls on structures and gold mineralisation in Victoria. Fosterville shows a similar stratigraphic succession to Bendigo, including thick shales and coarse amalgamated channel-sands. Both areas have linked systems of shale-hosted laminated quartz veins and thrusts that propagate from fold hinges and truncate fold limbs. However, the significant faults at Fosterville are all west-dipping, unlike Bendigo where faults dip both east and west.

Introduction

Central Victoria is a world-class orogenic gold province. Faults and folds within Ordovician turbidites host gold and associated mineralisation. Such turbidites occur across most of Victoria and in the field comprise monotonously interbedded sandstones and shales, although facies variations and lateral discontinuity of individual beds are characteristic at a local scale. This study of the Fosterville goldfield (Fig. 1) follows a review of the Bendigo and Ballarat East goldfields by Boucher et al., 2008a, 2008b. The majority of the research and development of the stratigraphic logging and correlation methods, now used widely in Victoria, were conducted at Fosterville.

Mining commenced in Fosterville at 1894 and was reinvigorated between 1986 and 2001 when a series of shallow oxide pits was excavated along several parallel fault systems. Fosterville Gold Mine are currently exploring and mining the down-plunge, sulphide mineralisation beneath the oxide pits.

While nuggety gold characterises most Victorian deposits, the gold at Fosterville occurs mainly within fine-grained, disseminated arsenopyrite. The Fosterville mineralisation is structurally (fault) controlled, occurring as selvages to quartz-carbonate vein stockworks beside late brittle faults (Roberts et al., 2003). Related, mineralised faults have been identified over a strike length of 14 km on the mining lease. This study concentrates on the longest of these fault systems which includes the Phoenix, Fosterville and Western Bounding Faults.

Figure 1. Location map showing the turbidite-hosted gold deposits discussed in this series of papers.

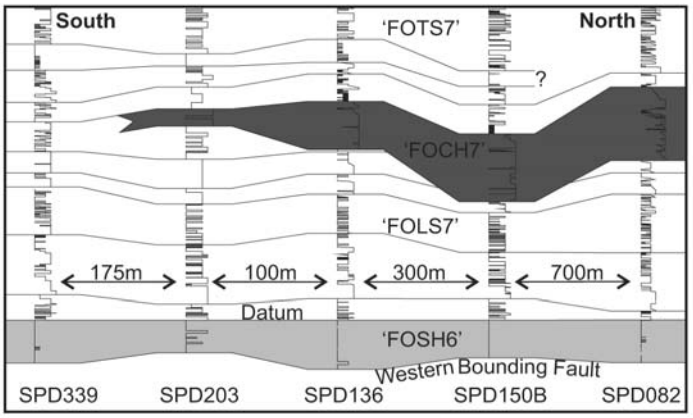
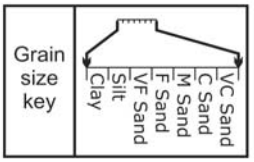


Figure 2: True thickness correlation diagram of sedimentary rocks in the hanging wall of the Western Bounding Fault.



Detailed logging of sediments in the hanging-wall above the Western Bounding Fault (Fig. 2) enabled correlation between drillholes, but it took several years to link the stratigraphy of the hanging-wall succession with that of the sedimentary rocks to the east. Eventually, stratigraphic correlation enabled detailed cross-sections to be constructed, fold geometries to be constrained and fault paths and offsets to be determined even when the drilling was widely spaced (typically 50 m spaced holes on sections 100 m apart). A total of 163.3 km of oriented diamond-tailed drilling from 506 drillholes has provided a large dataset. Many holes were stratigraphically logged so that a detailed correlation and interpretation process could take place.

Unlike elsewhere in Victoria, there is no formal mine stratigraphy at Fosterville. Instead a coded numbering system has been used to identify units (Fig. 3). Until the footwall and hanging-wall successions were correlated, they were given the prefixes 'FO' and 'HA' respectively. Thick shales are denoted as 'SH' and amalgamated channel-sands as 'CH'. The 'shale-topped sands' (STS) above and below the channel-sands are designated 'TS' and 'LS' respectively. Packages from the top of a shale to the top of the next shale above are considered analogous to a formation and are assigned a number for the combined LS/CH/TS/SH facies (Fig. 2).

Fosterville stratigraphy

A stratigraphic succession of almost 1,000 m has been identified at Fosterville, including the portion shown in figure 3. Sedimentary units have been correlated over a total distance of 10 km within the mine lease and in exploration drilling to the south. The stratigraphy is dominated by a monotonous succession of STS punctuated by thick shales and channel-sands, as is the case elsewhere in Victoria.

The most notable shale is 'FOSH13' (Fig. 3) which exceeds 75 m in thickness. This is three times the thickness of any shale seen elsewhere in central Victoria, which rarely exceed 10 m. Each of the thick shales at Fosterville host laminated quartz veins that are usually less that 10 cm thick but can reach 80 cm. The thick shales at Bendigo similarly host laminated quartz veins (Boucher et al., 2008a), however, the latter are virtually absent at Ballarat East (Boucher et al., 2008b).

Some of the shales at Fosterville are carbonaceous black shales. The most notable is 'FOSH6', colloquially referred to as the 'Black Shale', which

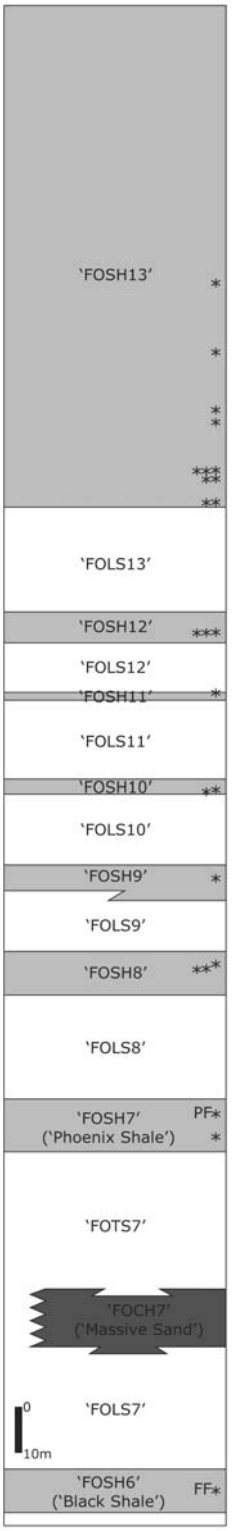


Figure 3. Stratigraphic column highlighting thick shale units and major bedding-parallel, laminated quartz veins (*). The stratigraphic positions of the Phoenix (PF) and Fosterville (FF) Faults are shown.

averages 10 m thick and is commonly faulted by the bedding-parallel Western Bounding and Fosterville Faults (Figs 4 & 5). Laminated, ripple-bedded, massive and black siltstones/claystones provide characteristics that makes each of the shale units uniquely identifiable.

The shale units at Fosterville can be correlated over significant distances without significant changes in thickness or internal character. This differs from Bendigo where the shales have a more restricted and varied distribution. As a result of the extensive shale development at Fosterville, the laminated quartz veins that are hosted within the shales are well represented. At Bendigo where shale thickness can be variable, the accompanying laminated quartz veins have a more restricted distribution.

A notable hanging-wall marker unit is 'FOCH7', the 'Massive Sand'. This comprises coarse and very coarse amalgamated channel-sands. Like the channel-sand units at Bendigo and Ballarat, 'FOCH7' is typically just over 10 m thick. A second channel-sand unit, not shown in figure 3, occurs about the same distance above 'FOSH13' as 'FOCH7' does below it. Channel-sands comprise a small percentage of the overall stratigraphy at Fosterville and it is interesting that the mine successions at Bendigo, Ballarat and Fosterville all occur close to or within this rare facies.

The extent of channel-sands at Fosterville are constrained by drilling (Fig. 2). In the hanging-wall in the northern part of the study area, 'FOCH7' is about 10 m thick (Fig. 4). However, the facies dies out dramatically (Fig. 5) and are not observed in the south (Fig. 6). Channel-sands have not been seen to the east of the Phoenix Fault (Fig. 4) and so the channel margin must lie somewhere between the two west-dipping limbs. The distribution of 'FOCH7' shows that the overall direction of the flow in the channel was to the northeast. While the lower boundary of the channel facies is conformable overall, there are local facies changes that suggest the channel is erosional (Fig. 2).

Stratigraphic controls on the development of veins, faults and folds

Laminated quartz veins are common at Fosterville within thick shale hosts. Stockwork quartz occurs close to major faults and is especially well developed in sand units. Away from the faults, veins exploit axial-planar cleavage in shales and radial cleavage in sandstones. This is more similar to the vein styles seen at Bendigo (Boucher et al., 2008a) than those at Ballarat (Boucher et al., 2008b).

The fault system at Fosterville is a series of faults that breach a parasitic fold on a large west limb. West-dipping beds persist for at least 600 m to the west of the Western Bounding Fault. It is uncertain how far west-dipping beds extend to the east. Figure 5 best demonstrates how faults are linked to laminated quartz veins hosted by thick shales above the syncline. Unlike Bendigo where the folds are more symmetrical and linked fault systems dip both to the east and west, the west-verging fold system at Fosterville hosts mostly west-dipping faults. Without significant east-dipping faults, there is little opportunity for neck or saddle reef development as occurs in the fold hinges at Bendigo (Boucher et al., 2008a).

As a general rule, the thicker the shale the greater is the associated fault offset. Multiple and thicker laminated quartz veins are seen in the thicker shales. The Phoenix and Fosterville Faults both have approximately 150 m of displacement (Figs 4 & 5). Fault offset diminishes where the associated shales are thinner and there is only about 5 m of displacement below the thin 'FOSH11' (Fig. 5). In contrast, a large fault system with significant offset is associated with 'FOSH13' (Fig. 6).

At Ballarat and Bendigo, there is good vein development in the channel-sand units. This is not apparent in the hanging-wall units at Fosterville. However, sandstones contain good stockwork vein development when east-dipping beds are truncated by west-dipping faults.

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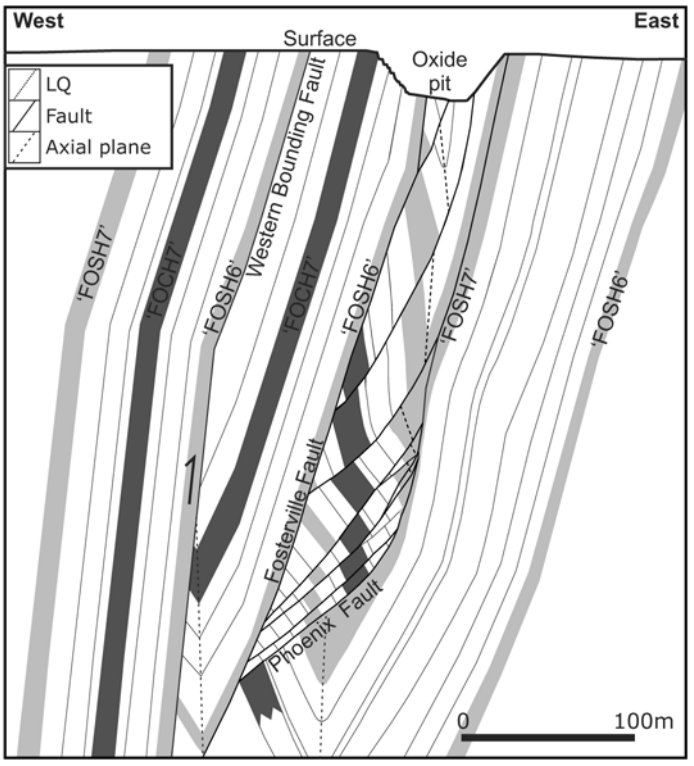

Figure 4. Section 8150mN showing major shale and channel-sand units, major faults and laminated quartz veins (LQ's).

Stratigraphic Controls on Structures and Mineralisation in Central Victoria 3: Fosterville

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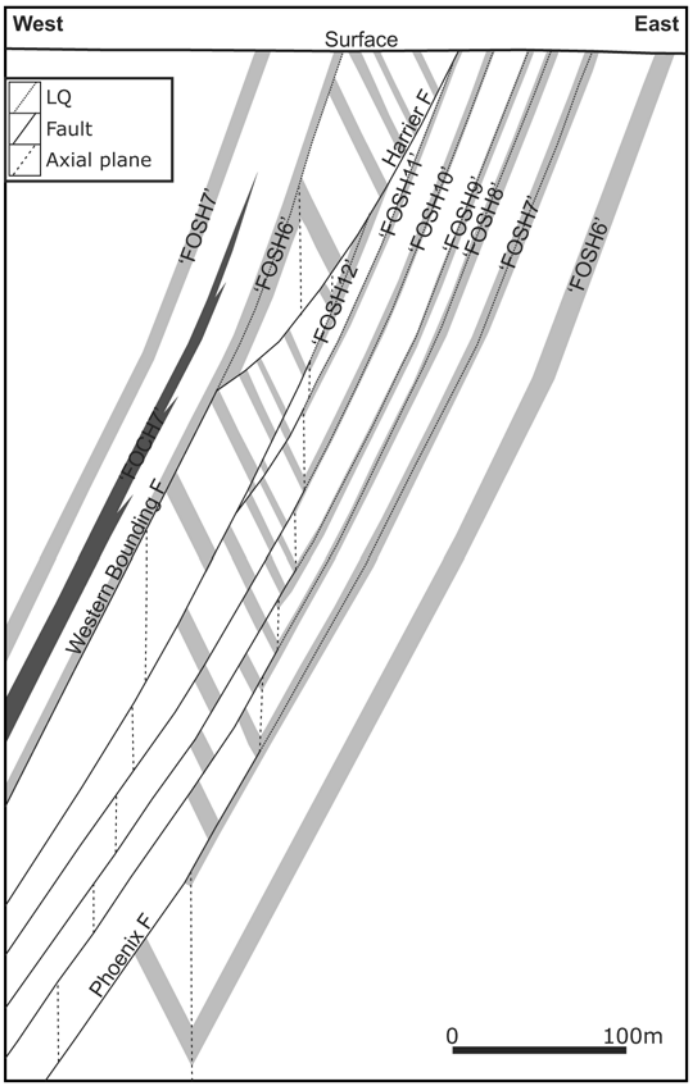

Figure 5. Section 7100mN showing major shale and channel-sand units, major faults and laminated quartz veins (LQ's).

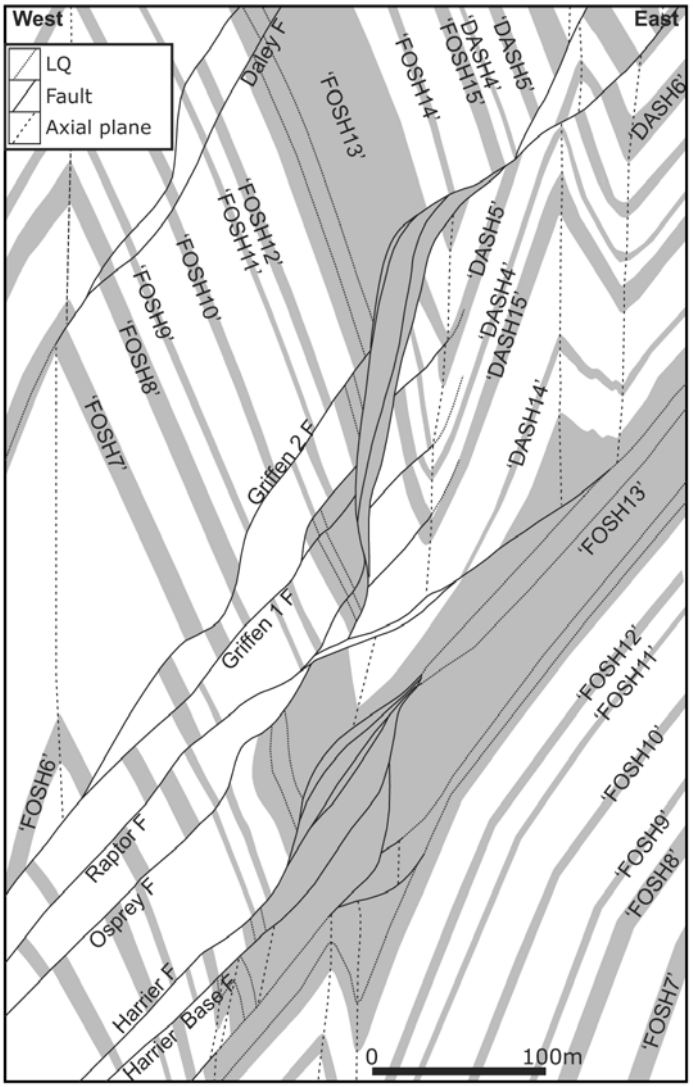

Figure 6. Section 5400mN showing major shale and channel-sand units, major faults and laminated quartz veins (LQ's).

Folding and fault styles at Fosterville

Folds at Fosterville are of upright chevron and occasional open style with vertical axial surfaces. Overall, the folds in the mine area are parasitic on a larger west limb. A domal structure culminates at about 8800mN and hinge lines plunge gently north and south of this point. The dip of the faults and associated mineralisation is controlled by the plunge of the folds. Folds have interlimb angles of between 40° and 60°, similar to those at Bendigo but greater than those at Ballarat.

The overall fault style is dominantly west-dipping and east-dipping faults are rare and small. As at Bendigo, faults typically are linked systems of laminated quartz veins and thrusts that propagate from fold hinges and truncate fold limbs. This is best seen in figures 4 & 5. The structural geometry becomes significantly more complex when the thick 'FOSH13' is faulted (Fig. 6).

At Fosterville, laminated quartz veins are not mineralised, in contrast to Bendigo where they commonly contain good nuggety gold. The best mineralised fault positions occur when east-dipping hanging-wall beds overlie west-dipping footwall beds, such as along the Phoenix Fault (Fig. 4). Significant fault displacement was imperative in providing a good down-dip window for mineralisation to occur. Where east-dipping beds occur in both the footwall and the hanging-wall, mineralisation is typically patchy and low grade. Without bedding control, faults that transect the east limb have a more erratic path. This is best seen in figure 6. Such faults change dip along their path. In section 5400 mN (Fig. 6), the two Griffin Faults split from a single fault further north. The anastomosing Harrier Fault is a single discrete fault elsewhere. The Osprey Fault ramps to become vertical in one of the axial surfaces.

The hanging-wall stratigraphy is repeated by the Western Bounding Fault on section 8150 mN (Fig. 4). This fault is mostly parallel with the stratigraphy, but lower down in the system it cuts across bedding and merges with the faults below. A drag syncline occurs beneath the fault where beds are truncated (Fig. 4). The Western Bounding Fault must have considerable displacement in order to repeat the stratigraphy. It is likely that this faulting occurred during early deformation of the succession. There is no mineralisation associated with the fault and this supports the notion that it formed and locked up earlier than the later mineralised faults.

Conclusions

Fosterville has similar sedimentary facies to other mines in central Victoria, but a thicker mapped stratigraphic succession reveals numerous thick shales and comparatively few channel-sand units. The stratigraphy can be correlated over many kilometres along strike and has been important in reconstructing the geology. Fosterville is dominated by west-dipping, linked faults that propagate from shale-hosted bedding-parallel laminated quartz veins across fold hinges and truncate opposing limbs. This is also seen at Bendigo, but not at Ballarat where thick shales are rare. However, Bendigo has east-dipping as well as west-dipping fault systems. Unique to Fosterville is a complete thrust-repeated succession and a shale that is three times thicker than any other yet seen in central Victoria. ▲▲

Acknowledgments

The management at Fosterville showed great initiative in developing and supporting the stratigraphic studies that have enabled a greater understanding of the structural complexity of the area and proved the benefit of detailed geological investigations. In particular, Chris Roberts, Trevor Jackson and Neil Norris provided enormous support. Steve King (Solid Geology) contributed valuable discussions during concurrent structural studies. The senior author is particularly grateful to the numerous staff geologists and research students who diligently collected data, assisted with field mapping and contributed to geological understanding of Fosterville. Thanks to Allan Rossiter for assisting with the final editing.

References

Boucher, R. K., Fraser, R. M. & Hill, R. L., 2008a. Stratigraphic controls on structures and mineralisation in central Victoria 1: Bendigo. *AIG News* 91:1-6.

Boucher, R. K., Osborne, D. J. & d'Auvergne, P. B., 2008b. Stratigraphic controls on structures and mineralisation in central Victoria 2: Ballarat East. *AIG News* 92:6-8.

Roberts, C., Jackson, T., Allwood, K., Shawcross, M., Story, J., Barbetti, L., Tielen, R., Boucher, R. & Norris, N., 2003. Fosterville — rise of the Phoenix. The emerging goldfield at Fosterville. *The New Generation Gold Conference Abstracts.*

Complaints, Complaints, Complaints

Complaints Committee targets some Competent Persons!

The Complaints Committee has noted in announcements an increase in the use of the term *target* with an associated lack of transparency. In some examples, it would have been possible to substitute the words "inferred resource", or another resource or reserve category, for "target" in the announcement without the reader being confused by the syntax.

Clause 18 of the JORC Code is quite clear about the use of the term *target* within the context of exploration results. A target is a conceptual body of mineralization of a desired type, size, metallurgy etc that a company is hoping to discover. Once you have found your target, it's no longer a target!

The JORC Code states (Clause 18): "information relating to exploration targets must be expressed so that it cannot be misrepresented or misconstrued as an estimate of Mineral Resources or Ore Reserves. The terms Resource(s) or Reserve(s) must not be used in this context. Any statement referring to **potential quantity** and grade of the target must be expressed **as ranges** and must include (1) a detailed explanation of the basis for the statement, and (2) a proximate statement that the potential quantity and grade is conceptual in nature, that there has been insufficient exploration to define a Mineral Resource and that it is uncertain if further exploration will result in the determination of a Mineral Resource."

To be on the safe side, Competent Persons should follow Clause 18 and if in any doubt, substitute the words "inferred resource" for "target". If it still makes sense (remember targets must be expressed as ranges), you may have overstepped the transparency mark.

Current complaints

Two complaints are currently being investigated by the Complaints Committee. The complaint mentioned in the May AIG News was closed with a warning issued to the member who signed the announcement as Competent Person. ▲▲

Where Macro Cosmos Meets Micro Cosmos

Hans Jelbring, M.Sc (Elect. Eng) Ph.D.
Climatologist

THIS PAPER COMMENTS on a monograph titled "The global atmospheric electric circuit and its effect on cloud microphysics", by B. A. Tinsley, 2008, Physics Department and Centre for Space Sciences, University of Texas at Dallas. His paper should be read and applied in research for several more reasons than the title suggests. It might point to a more meaningful research direction about climate change when the simplistic, unproven "greenhouse gas" hypothesis has finally been scientifically debunked.

Living in the Stockholm area, Sweden, at latitude 60°N, I am well aware that thunder and lightning occur mostly in summer afternoons. Cold fronts may pass our city mostly on their way south to southeast and thunder announces their passing by, but some years ago an extraordinary event happened — during three consecutive summer nights there was thunder and lightning around midnight but not at all during the day. Was it a simple coincidence or was some unknown physical process working that caused the cumulus nimbus to develop during the three nights? As a meteorologist I know that when moist air is forced upwards rain will never be far away. Once staying two weeks during autumn in the Philippines on the Luzon Peninsula (100 miles south of Manila) the clear sky turned into black cumulus nimbus clouds on three sides during late afternoon and an unbelievable lightning display started and lasted well into the evening. 1–3 lightning flashes per second made it possible to read a newspaper outdoor in the darkness before the clouds and rain hit. This happened more or less every day during my visit. My conclusion is clear. Strong (mechanical) upward atmospheric motion of moist air, for whatever reason, will produce lightning and thunder. Tinsley would agree but he would also like to cover the impact of electricity in the atmosphere down to the size of molecules.

Tinsley´s paper is ambitious, to say the least. It is not far away from a doctoral thesis including 31 pages, contents with 7 chapters and more than 200 references. Does the quality of the content match a doctoral thesis? The answer is yes but the title should be somewhat changed and in any case Tinsley already has his PhD. His detailed knowledge in the chosen subject was acquired during many years of research documented by a number of scientific papers.

What subjects does Tinsley´s paper treat? The main objective is to model atmospheric electric currents. Below is an attempt to further categorize the content.

A. It deals with global electrical currents in the troposphere as output and lightning, solar wind, Galactic Cosmic Rays (GCR), surface heating and aerosol concentration as input variables. He constructs an elaborate detailed model and sticks to facts in an impressive way. His choice of model is backed up by numerous references. He

describes spatial and temporal variations ranging from days to periods between glacial periods. His ambition is far reaching.

B. The process of ion production and charge separation in our atmosphere is presented in the presence of dust particles, cloud condensation nuclei (CCN) and ice forming nuclei (IFN).

C. He formulates a hypothesis relating to electric effects on scavenging (how droplets and ice particles grow) and how they partly evaporate when falling.

D. Global electrical currents, CCN and IFN are coupled to macro climate events such as regional pressure and temperature but also to extraterrestrial variables such as solar wind, reversals of the interplanetary magnetic field, sunspot evolution and GCR's, according to Tinsley´s major hypothesis.

This article will focus on the point D where the scientific knowledge is least developed. Here Tinsley's contribution is by acknowledging obvious problems in an open way and seeking hypotheses and solutions in a creative manner. Tinsley is well aware of the existence of too many odd correlations between climate variables and solar variables to just refuse considering them. His attempt to penetrate and understand the enormously complex system producing long term climate variations is admirable. The micro processes he describes undoubtedly depend on the formation of ions and electrical currents. He and many others have found correlations between electrical atmospheric currents and macro climatic variables. But he also says: "As noted in Tinsley and Deen (1991) there is evidently an amplification of energy from the GCR input (or the global circuit changes, which have about the same energy) to some of the meteorological dynamical outputs by a factor of order 10^7. For an acceptable mechanistic explanation this amplification should be accounted for." Precisely, an unexplained magnification of 10 million times cannot be ignored.

Herman and Goldberg (1978) addressed the problem with correlations which lacked explanations in their book "Sun, Weather and Climate" (also cited in Tinsley´s reference list) by saying "The heart of the problem, that is, the physical processes and mechanisms that produce the observed correlations, is addressed in chapter 6. Here the discussion must be speculatory and in some cases naïve, because no hypothesis have been proven that explain the physical links to couple solar variations to troposphere." The book has 470 references and was published in 1978; Herman and Golberg´s work has mostly been ignored during the last 25 years.

Tinsley and these two authors have the correct approach. Many provocative correlations do exist and there have to be physical reasons for their existence. Tinsley has made a great effort to describe and promote the knowledge of atmospheric electrical currents, ion production and ion separation processes. His model will probably be accepted as the best available in due time regarding the global electrical currents and the reasons for its spatial and temporal variations. Tinsley himself is aware that at least 80% of the atmospheric electrical currents are produced by terrestrial physical processes, partly supported by my introductory observations. Extraterrestrial processes are modulating the variations. He is very detailed about describing all the processes that he considers worth including in the model. The weakest part is found in point D above. Still, his work (and paper) will become essential for future research in the field of climate change.

That weakness can be expressed in the following way. Many correlations have been observed between extraterrestrial variables (sunspots, solar wind etc), atmospheric electrical currents and climate variables. They cannot be denied by a serious scientist, which Tinsley certainly is. Figure 1 below illustrates how he considers the important variables to interact (fig.7 in Tinsley´s paper). The complexity of the system is obvious.

This complexity is at the heart of the problem. Mathematically a correlation between two process variables A and B doesn't necessarily prove that A is causing B or that B is causing A. Both can be caused by a (unknown?) third variable (or rather process) C. Such a situation is common in complex systems. There might be very little "cause" between the selected, well correlated, variables A and B. An unknown process is easy to dismiss and it is hard to analyse its influence. In this case there is a known physical process C at hand. Tinsley points to the fact that 80% of the global electrical atmospheric currents is caused by lightning in around 1000 cumulus or cumulus nimbus centra all around the world at any instance. The reason is that moist air is lifted upwards to an unusually high elevation. There are a number of physical processes that will cause the uplift to happen. Mechanical processes in ascending air will (always when far enough) create ions on small atmospheric particles, water nuclei and ice crystal nuclei, and cause the lightning.

There is one major forcing agent causing strong uplift besides hurricane formation and the equatorial "heat towers" along the equatorial Zone. Mobile Polar Highs (MPH's) have been described by

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Where Macro Cosmos Meets Micro Cosmos

Cont. from page 11

Professor Marcel Leroux during the past 30 years. Storms are by products of big MPH's. They start in polar areas, accelerate to a maximum speed around latitude 45 and slow down close to the equator. One MPH can cover half of South America. They are the generators of the worst snow blizzards known, such as the famous one that occurred in the US during 1899 when ice drifted into the Gulf of Mexico from the Mississippi River. Marcel, a physical geographer, bases his statements in the first place on observational evidence and satellite images are the key to his research results. He has written many papers relating to MPH's during his active life as a professor in Lyon, France. The name of his latest book is "Global Warming — Myth or Reality —The Erring Ways of Climatology". His work has mainly been rejected, probably since MPH's cannot be incorporated in the GCM's (General Circulation Models).

Another major physical process is the tidal action on the atmosphere (and in the oceans) which will modulate other physical processes acting on the atmosphere. My doctorial thesis was named "Wind Controlled Climate" as the heat release from the Earth has to be wind speed dependant. Climate change is treated on the basis that energy conservation has to be valid. One important conclusion is that extraterrestrial influences probably dominate long term climate on earth. Since gravity tides are not strong enough to explain the observed massive relocations of the atmospheric mass, an unknown physical process has to be at work. The dust content in Vostok ice cores is about 10 times higher during glacial periods than during the inter-glacial periods. There have to be physical reasons for the average wind speed to increase that much over a continent and probably also over the whole world.

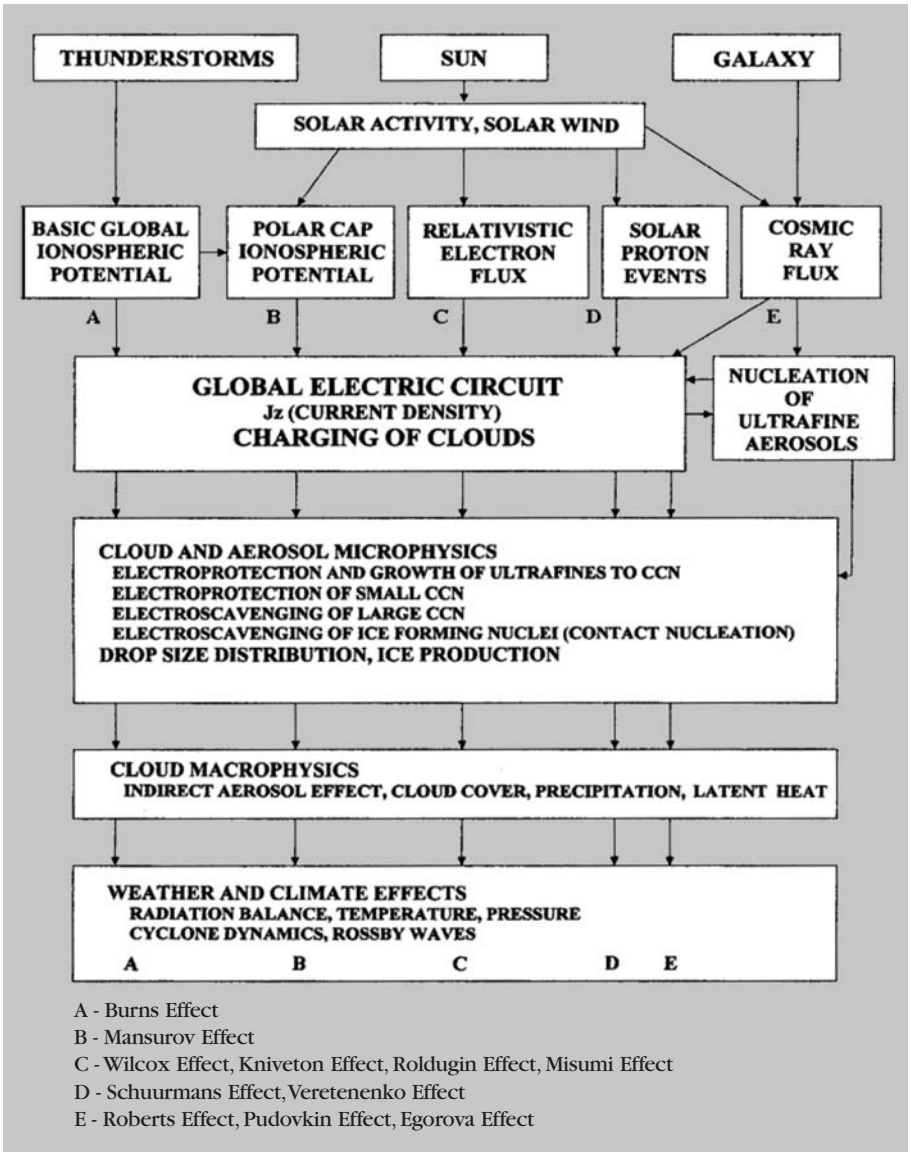


Figure 1: Block diagram showing part of the complexity between terrestrial and extraterrestrial factors relating to atmospheric electrical currents (Fig. 7. in Tinsley's paper)

Tinsley´s work suggests one solution to the enigma at hand, that micro electro-physics might be involved in changing the emission properties of our atmosphere, especially at polar areas. This would increase the build up of MPH's in Arctic and Antarctic regions and would strongly enhance the turbulence in our troposphere when moving towards the equator. Average wind speed would increase and the world would cool down. Horizontal Density Forcing (HDF) would force MPH's toward the equator as mentioned in my thesis. The centrifugal force would accelerate the cold dense MPH's along the surface of earth and they would theoretically reach a maximum speed at 45° latitude, just as observational evidence shows. The energy would be taken from the rotational energy of earth which is known to slow down about 1-2 milliseconds per century. There would not be any need for an energy "amplification" of the kind that Tinsley seeks but there would be an understanding from where the needed energy is originating. This loosely formulated hypothesis described here needs serious analysis.

It is my personal opinion that the existence of electricity, ions, ion separation and recombination plays a greater (and unknown) role in atmospheric radiation processes, especially in IR emission from the earth, than currently accepted. Furthermore, correlations between earthly climate variables and extraterrestrial variables will, sooner or later, be possible in terms of strict physics. The work of B.A. Tinsley is an important contribution in reaching such an understanding. When this happens true long-term climate predictions will certainly become a reality benefitting mankind in a way which is hard to comprehend today. ▲▲

References

Herman, John A. and Goldberg, Richard A., Sun, Weather, and Climate, 1978, 360 pp, NASA, Washington

Jelbring Hans R. Thesis, Wind Controlled Climate, 1998, 111 pp, Paleogeophysics & Geodynamics, Stockholm University

Leroux, Marcel, Global Warming — Myth or reality — The erring ways of Climatology, 2005, 509 pp, Université Jean Molin, Lyon, Springer and Praxis Publishing

Tinsley, B. A., The Global atmospheric electric circuit and its effect on cloud microphysics, 2008, 31 pp, Reports on Progress in Physics 71, IOP Publishing Ltd

National Science Week Activities

The GSA and AIG combined to run two events promoting geoscience in the community as part of National Science Week in August.

Queensland National Science Week Coordinating Committee organised the "Brainwaves at the Ekka" Festival which ran at the Brisbane Showgrounds from the 7th to the 16th August. The AIG and GSA combined to run a joint exhibition booth in the Science Pavilion, alongside CSIRO, QUT, UQ, Young Scientists of Australia and other organisations.

This was a huge undertaking for AIG/GSA and we assembled an interesting display aimed at the general public, both young and old, promoting the importance and value of geoscience in the community. In addition we produced a brochure that was included in the Science Showbag, also containing a mineral and rock sample for identification.

The booth was manned for ten days by a combination of volunteer AIG/GSA members, supplemented by earth science students from QUT and UQ. Whilst a formal post-mortem of the event has yet to be held, I think it is fair to say it was a tremendous success and raised the profile of geoscience to a large cross section of Queenslanders.

On the 20th August GSA/AIG combined again to present the display created for the EKKA at Qld Museum during Science Week proper. In addition to the hands-on display the AIG and GSA each presented a talk. During the day Mark Berry hosted a talk titled Careers in Geoscience with undergraduate students Larissa Hansen (UQ) and Alex Hepple (QUT). In the evening Sue Golding presented a talk on Early Life in the Pilbara.

The GSA Qld division also presented its annual awards to high school students who achieve outstanding results in earth sciences in year 12 and to the highest achieving earth science undergraduate from each of UQ, JCU and QUT.

The organisation of both of these events took a substantial effort and the AIG would like to acknowledge and thank everyone who assisted. In particular I would like to thank Friedrich von Gnielinski (Hon Treasurer and Membership Secretary - GSA Qld Division), for without his input we would have been unable to stage these events.

Mark Berry ▲▲

Top:Gregg Webb (GSA Qld Division Chair), Friedrich von Gnielinski (EKKA booth coordinator, GSA Qld Division) and Mark Berry (AIG Qld Branch Chair).

Centre Top: Booth volunteers Michael Hawtin and Geoff Derrick (with GSA caps) talking shop.

Centre Bottom: A budding geologist investigating some of the samples on display.

Bottom: The booth packed out with interested EKKA-goers.

Exploding Asteroid Theory Strengthened by New Evidence Located in Ohio, Indiana

WAS THE COURSE of life on the planet altered 12,900 years ago by a giant comet exploding over Canada? New evidence found by UC Assistant Professor of Anthropology Ken Tankersley and colleagues suggests the answer is affirmative.

Geological evidence found in Ohio and Indiana in recent weeks is strengthening the case to attribute what happened 12,900 years ago in North America — when the end of the last Ice Age unexpectedly turned into a phase of extinction for animals and humans — to a cataclysmic comet or asteroid explosion over top of Canada.

A comet/asteroid theory advanced by Arizona-based geophysicist Allen West in the past two years says that an object from space exploded just above the earth's surface at that time over modern-day Canada, sparking a massive shock wave and heat-generating event that set large parts of the northern hemisphere ablaze, setting the stage for the extinctions.

Now University of Cincinnati Assistant Professor of Anthropology Ken Tankersley, working in conjunction with Allen West and Indiana Geological Society Research Scientist Nelson R. Schaffer, has verified evidence from sites in Ohio and Indiana — including, locally, Hamilton and Clermont counties in Ohio and Brown County in Indiana — that offers the strongest support yet for the exploding comet/asteroid theory.

Samples of diamonds, gold and silver that have been found in the region have been conclusively sourced through X-ray diffractometry

Ken Tankersley

in the lab of UC Professor of Geology Warren Huff back to the diamond fields region of Canada.

The only plausible scenario available now for explaining their presence this far south is the kind of cataclysmic explosive event described by West's theory. "We believe this is the strongest evidence yet indicating a comet impact in that time period," says Tankersley.

Ironically, Tankersley had gone into the field with West believing he might be able to disprove West's theory.

Tankersley was familiar through years of work in this area with the diamonds, gold and silver deposits, which at one point could be found in such abundance in this region that the Hopewell Indians who lived here about 2,000 years ago engaged in trade in these items.

Ken Tankersley seen working in the field in a cave in this publicity photo from the National Geographic Channel.

Prevailing thought said that these deposits, which are found at a soil depth consistent with the time frame of the comet/asteroid event, had been brought south from the Great Lakes region by glaciers.

"My smoking gun to disprove (West) was going to be the gold, silver and diamonds," Tankersley says. "But what I didn't know at that point was a conclusion he had reached that he had not yet made public — that the likely point of impact for the comet wasn't just anywhere over Canada, but located over Canada's diamond-bearing fields. Instead of becoming the basis for rejecting his hypothesis, these items became the very best evidence to support it."

Additional sourcing work is being done at the sites looking for iridium, micro-meteorites and nano-diamonds that bear the markers of the diamond-field region, which also should have been blasted by the impact into this region.

Much of the work is being done in Sheriden Cave in north-central Ohio's Wyandot County, a rich repository of material dating back to the Ice Age.

Tankersley first came into contact with West and Schaffer when they were invited guests for interdisciplinary colloquia presented by UC's Department of Geology this spring.

West presented on his theory that a large comet or asteroid, believed to be more than a mile in diameter, exploded just above the earth at a time when the last Ice Age appeared to be drawing to a close.

The timing attached to this theory of about 12,900 years ago is consistent with the known disappearances in North America of the wooly mammoth population and the first distinct human society to inhabit the continent, known as the Clovis civilization. At that time, climatic history suggests the Ice Age should have been drawing to a close, but a rapid change known as the Younger Dryas event, instead ushered in another 1,300 years of glacial conditions. A cataclysmic explosion consistent with West's theory would have the potential to create the kind of atmospheric turmoil necessary to produce such conditions.

"The kind of evidence we are finding does suggest that climate change at the end of the last Ice Age was the result of a catastrophic event," Tankersley says.

Currently, Tankersley can be seen in a new documentary airing on the National Geographic channel. The film "Asteroids" is part of that network's "Naked Science" series.

The new discoveries made working with West and Schaffer will be incorporated into two more specials that Tankersley is currently involved with — one for the PBS series "Nova" and a second for the History Channel that will be filming Tankersley and his UC students in the field this summer. Another documentary, this one being produced by the Discovery Channel and the British public television network Channel 4, will also be following Tankersley and his students later this summer.

As more data continues to be compiled, Tankersley, West and Schaffer will be publishing about this newest twist in the search to explain the history of our planet and its climate.

Climate change is a favorite topic for Tankersley. "The ultimate importance of this kind of work is showing that we can't control everything," he says. "Our planet has been hit by asteroids many times throughout its history, and when that happens, it does produce climate change." ▲▲

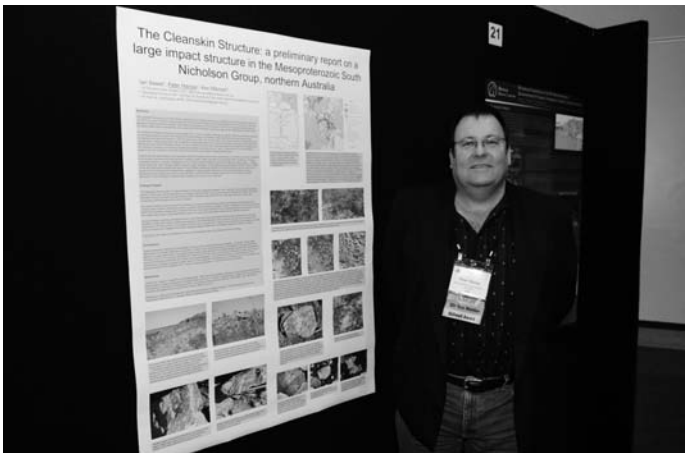
AESC — Phew, What an Event!

THE 2008 AUSTRALIAN EARTH SCIENCES CONVENTION, held in Perth 21 - 24 July was a great success. Undertaken as a joint venture between the Geological Society of Australia (GSA) and the AIG, the convention attracted about 850 registrants from Australia and overseas and showcased Australian geoscience at its best. Numerous press and media events ensured that the general public was caught up in the event.

With 10 concurrent sessions after the plenary each day, and pre- and post-excursions and workshops as well as a large number of trade exhibitors, it was a busy week for all. We were spoilt for choice of which sessions to go to.

Special thanks for contributing so much to the successful conduct of the AESC must go to Program Director Jon Hronsky and Marcus Harris who both put in an enormous number of voluntary hours. Besides assisting with the mineral exploration part of the program, Marcus also pulled together the Students Nite (see separate article) held in conjunction with the AESC. Jocelyn Thomson also assisted and in particular manned the AIG booth, signing-up some new members and selling AIG publications.

The cooperation between GSA and AIG in organizing and running the event was excellent. ▲▲



Above Top: Jon Hronsky (Program Director) chairing plenary session
Above: Mike Smith in Rio Tinto (the largest sponsor of the AESC) booth
Bottom Right: Jocelyn Thomson manning the AIG Booth
Photos: Clark Rodda of Festival City Photography

Ground-Atmosphere-Ionosphere Interactions Related to Earthquakes: How can Earthscope Help?

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RECENT EARTHSCOPE ACTIVITIES have been concerned with monitoring earthquake-related parameters from using surface stress (INSAR) to deep borehole stress measurements (SAFOD). In this paper we draw attention to other parameters possibly related to earthquakes (EQ) that can be monitored from the ground and from space. Specifically, we propose to initiate a similar activity under TERRASCOPE or under some other future mission concept.

Recent field studies and simultaneous satellite observations add confidence to reported observations of electromagnetic (EM) emissions before large earthquakes. There is likewise mounting evidence that, prior to seismic activity, electric fields are transmitted from the ground into the atmosphere, that thermal anomalies may become observable, that ions may be emitted from the ground, that the atmospheric conductivity is affected, that the ground potential may change locally or regionally, etc. Some authors have considered the possibility of an inverse connection — from the atmosphere to the ground, causing seismic activity. Increased lightning activity, due to growing seismic activity, and the large currents thus induced may have an effect on the fracturing or microfracturing of rocks, focusing the EQ energy release [Pulinets, 2000]. Several ongoing international satellite missions, COMPASS (Russia, Poland, 2001), DEMETER (France, Japan, Russia, 2002) and VARIANT (European Space Agency, Ukraine, 2001), are aimed at retrieving ionospheric plasma anomalies that may be related to EQ activity (M>5).

A recent experimental study [Freund, 2000] has indicated a direct connection between stress applied to rocks and the generation of charge carriers, causing electric currents and affecting surface potentials. These new results may intensify the interest in future similar studies.

1. Observable Changes on the Surface of the Solid Earth

1.1. Positive Holes

Electrical phenomena preceding large earthquakes have been mentioned or described in the literature for centuries. What has been lacking, however, was a fundamental understanding of the nature of the electric charges in rocks and how they may be generated in the crust.

The keyword is "water" – not liquid water that fills the pores in rocks but small amounts of H_2O that dissolve in minerals, even those that are nominally anhydrous, when they crystallize in H2O-laden magmas or recrystallize in H_2Oladen metamorphic environments. It is widely (but wrongly) thought that the dissolution of H_2O ends with the formation of hydroxyl, OH^-. Instead, it has been noted early that hydroxyl pairs adjacent to cation vacancies undergo an electron transfer inside the mineral matrix by which two oxygens become oxidized from their usual 2– to the –1 oxidation state, while two protons, H^+, become reduced to molecular H_2 [*Martens et al*., 1976]. The O^-. thus generated undergo spin pairing to form peroxy bonds or peroxy links, $O_3Si/^{OO}\backslash SiO_3$.

From the viewpoint of semiconductor physics, an O^-. in an O^{2-} matrix is a defect electron or "positive hole", i.e. a charge carrier that resides in and travels via the O 2p-dominated valence band. A peroxy represents a positive hole pair, PHP, electrically inactive and dormant. When the peroxy bond breaks, positive holes are released. These charge carriers are highly mobile and turn the mineral or rock momentarily into a p-type semiconductor [*King and Freund*, 1984].

After it was observed that stress, leading to dislocation movement, and even acoustic waves are capable of activating PHPs, the idea arose that, when rocks are subjected to ever-increasing stress in an EQ-prone region, they will undergo plastic deformation and massive microfracturing. Each dislocation that moves and each microcrack that opens and closes explosively, emitting an acoustic wavelet, would activate positive holes. The expected large number of charge carriers would lead to large currents – with predictable consequences amenable to remote sensing.

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Ground-Atmosphere-Ionosphere Interactions Related to Earthquakes: How can Earthscope Help?

Cont. from Page 17

1.2 Changes in Ground Potential

Because the positive holes turn any rock momentarily into a pure p-type semiconductor [King and Freund, 1984], the charge carriers will propagate outward from their source volume. When they intersect the surface of the Earth, the ground potential is expected to become highly positive [*Freund and Liu*, 2000]. Two questions arise: (1). What would be the consequences of a regional ground potential that trends toward highly positive values? (2). How can the effects of an anomalously high positive ground potential be measured, either on the ground or from space?

1.3 Thermal Anomalies on the Ground

Using remote sensing and data from NOAA weather satellites 100-500 km patches of thermal anomalies have been identified in areas where strong earthquakes were to occur [Tronin, 1999]. It is possible that anomalies arise from the migration of positive holes to the Earth's surface. Using multi-spectral near-IR to mid-IR remote sensing techniques and data from Earth Observation System satellites (NASA/MODIS) we currently analyze the two large earthquakes that occurred in Jan. 2001 in El Salvador and NW India. Pending laboratory confirmation [Geeing et al. 1999], a correlation seems to exist between the EQ magnitude and the luminance temperature.

2. Atmopsheric Effects

2.1 Atmospheric Electricity

If ULF EM waves impinge on electrically charged clouds, their transverse components should be attenuated exponentially because of the so-called "anomalous skin effect". Electric currents induced by these waves could then be discharged by intercloud, cloud-to-cloud, cloud-to-ground lightning. When the attendant field leads to a diffuse discharge between the cloud layer and the upper atmosphere phenomena like "blue jets", "sprites", and upward "super bolts" may occur.

The normal ground potential varies between 0.1- 100V/m, but, in the case of thunderstorms or in areas of an impending earthquake, it can rise to values up to 1000V/m. Such high ground fields influence the conductivity of the lower atmosphere. Gas emanation including radon release from the ground affect the aerosol content and causes the conductivity to increase up to fivefold above the background level [Alperovich and Fedorov, 1999]. As a result, prior to an EQ, the vertical profiles of humidity, pressure and temperature are changed; similar to the changes brought about by thunderstorms. Intense electrical field nears the ground that is normally seen as a result of meteorological events can generate clouds and ground-hugging fogs. Cloud-to-ground lightning strikes occur before the peak of the increased atmospheric conductivity in the air. Changes in the lower atmosphere-ground conductivity are related to the migration of EM carriers from lower atmosphere to the ionosphere (F–region).

2.2 Atmospheric Aerosol Content Variations

Aerosol content and atmospheric instability parameters also change under the influence of ground charges. It has been proposed that a thin aerosol layer appear due to light ions emitted from the ground. Fe ions and other aerosols possibly play a role in transmitting the field from the ground to the upper atmosphere and to ionosphere. Several studies propose different time scales for these processes, ranging from a weeks to a few days and hours before the main shock.

3. Ionospheric Changes Related to Strong Earthquakes

3.1 Lithosphere-Ionosphere Interactions

Anomalous VLF/ELF emissions from the ground and anomalous ionosphere reactions over seismic zones have demonstrated that, prior to strong EQ activity, the EM field and the plasma in the ionosphere and magnetosphere are affected. The ionospheric disturbances several days before the seismic event are reportedly identified in an anomalous absorption of long wavelength radio waves in the Earth-ionosphere wave guide, in variations of the electron density and the total electron content (TEC), both positive and negative, and in EM waves and electric fields measured at magnetospheric or ionospheric levels [Molchanov and Haykawa, 1995].

Different ELF/VLF EM emissions are divided into two groups: precursor emissions (a few hours before an EQ in the frequency range 0.01-1000Hz) and emissions after an EQ (or after a volcanic eruption), the latter being attributed to acoustic-gravity waves [Parrot, 1995]. Though the EM precursors cover a wide frequency range, they seem to have three common features: emissions appear 5-10 days before an EQ and few days afterwards; they are mostly related to the tectonic type of EQ; and they are only observable within a radius of 500 km of the focus.

4. Main Areas of Study in Ground-Atmosphere-Ionosphere Interactions Related to Strong Earthquakes and Possible Connection to Ongoing Programs

Ground perturbation – collecting all seismic and non-seismic data for ground-source models. Disturbances as evidenced by changes in strain, in deformation, in water levels, in the gas content, in the electromagnetic field, and their respective temporal and spatial distributions. Looking for correlation between EM and acoustic emission using very precise downhole observations. These emissions are considered to be the manifestation of micro-processes connected to micro fracturing. Mid-IR luminescence from the ground prior to strong earthquakes from data provided by GEOS and NASA EOS satellites. Most closely relevant activities are SAFOD, USArray, and GESS.

Upper atmosphere. Using VLF transmitter signals, fluctuations in the plasma density over the wave path may be correlated to EQ activity by measuring the shift in terminator time (tt). The tt is defined as the time when the diurnal phase variations exhibit a minimum around sunrise and sunset. Using this approach a correlation has been found between VLF emission and planetary waves. This has been used to postulate how near-to-ground electric perturbations might reach the upper atmosphere through slow atmospheric gravity waves, through changes in the ground potential or in lightning activity [Molchanov and Hayakawa, 1998;Clilverd et al., 1999]. Most relevant projects are GESS or future ground observation systems.

Plasma density fluctuations and wave emission. Sub-ionospheric signals are reflected at the lower D region of the ionosphere, and the question arises whether seismic or preseismic activity may affect the upper ionosphere? Latest satellite data from 500-700 km (low geomagnetic activity, the main ionospheric maximum and daytime observations), suggest a correlation between seismic activity and a variation in the electron density [Hayakawa, 2000]. There is no equivalent data as part of EARTHSCOPE.

GPS monitoring of the ionosphere. Using the 24 GPS satellites with local receiver networks it is possible to continuously monitor the ionosphere. The ionosphere acts as dispersive medium for the GPS signals, while the troposphere is non-dispersive. After removing from the received signal tropospheric effects on the carrier phase and correcting for the pseudo-range, the group delay of the propagating signal along the travel path becomes a measure of the Total electron Content (TEC). Recent studies have shown that anomalies of the TEC values correlate with strong EQs to 1-4 days before the main event [Liu at all, 2000]. Most relevant project is UNAVCO.

Conclusion

Several parameters, measurable from the ground or from space, reportedly correlate with strong EQ activity (M>5). We propose that these parameters be included into EARTHSCOPE. These parameters are apparently connected to and caused by the progressive build-up of high tectonic stress. They can be time-correlated by monitoring the ground, the atmosphere, and the ionosphere. ▲▲

References

Alperovich L.and E.Fedorov, Perturbation of atmospheric conductivity as a cause of the litosphere-ionopshere interaction, In: Atmospheric and Ionospheric Electromagnetic phenomena associated with earthquakes, pp. 591-596, 1999.

Clilverd M., Craig Rodger, Neil Thomson Investigating seismoionospheric effects on a long subionospheric path, J.

Geophys. Res., 104, 12, pp. 171-179, 1999.

Freund F., Time-resolved study of charge generation and propagation in igneous rocks, J. Geophys. Res., 105, 11001-11019, 2000.

Geng N., M.Deng, C.Cui Simulated experimental studies on earthquake prediction by using infrared and microwave remote sensing, in: Atmospheric and Ionospheric Electromagnetic phenomena associated with earthquakes, pp. 751-758, 1999.

Hayakawa M., Electromagnetic phenomena associated with earthquakes, Bulletin of the University of Electro-Communications, 13-1, pp. 1-6, 2000.

Liu Y., Y.J. Chuo, S.A. Pulinets and H.F.Tsai, A stuffy on the TEC perturbations prior to the Rei-Li, Chi-Chi and Chia-Yi earthquakes, Geophys. Res. Lett, 2000.

Molchanov O. and M.Hayakawa, Subionospheric VLF signal perturbations possibly related to earthquakes, J. Geophys. Res., 103, 17, pp. 17489-17504, 1998.

Molchanov O., M.Haykawa V.Rafalsky, Penetration characteristics of electromagnetic emissions from an underground seismic source into the atmosphere, ionosphere, and magnetosphere, JGR, 106, A2, pp. 1691-1712, 1995.

Parrot M., Use of satellites to detect seismo-electromagnetic effects, Adv. Space Res., 15, 11, pp. 27-35, 1995.

Pulinets.S, K.A.Boyarchuk, V.Hegai, C.Kim, A.Lomonosov Quasielctrostatic model of atmosphere-thermosphereionosphere coupling, Adv. Space Res., 26, 8, pp. 1209-1218, 2000.

Tronin A., Satellite thermal survey application for earthquake prediction, Atmospheric and Ionospheric Electromagnetic phenomena associated with earthquakes, pp. 716-746, 1999.

Geological Consequences of Large Meteoric Bodies Approaching the Earth – The Electrical Factor

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Abstract:

Kimberlite genesis is linked to disruptions in the Earth's electrical field caused by the approach of large meteoritic bodies, as well as their mechanical impact with the Earth. Previous work suggests that subterranean electrical discharges may not only cause earthquakes but also trigger the eruption of kimberlite. Here it is proposed that these disruptions of the Earth's internal electrical field are the result of external factors affecting the Earth's electric field, such as the close approach of a large meteoritic body. It is also suggested that crypto-ring structures may have a similar genesis, as they appear to have a spatial association with kimberlite diatreme fields.

Keywords: *kimberlite, meteorite, electric field, diatreme, ring structure*

The proposed model of kimberlite genesis by near-Earth intruder interaction suggested by the author is based on four separate groups of data. Until recently, each particular group showed no logical connection with the other three, but when considered collectively all appear related.

Group 1. Subterranean electrical discharges

Finkelstein and Powell [1] were the first to propose that subterranean electro-discharges ("subsurface thunderstorms") are the true cause of some earthquakes. Alekseevsky and Nikolaeva [2], specialists in diamond geology, expanded on this idea and first suggested that the cavities of kimberlite diatremes may be the breakdown channels of a "giant condenser" between the Earth's surface and mantle. Both of these hypotheses were supported by Vorob'yev [3], who suggested the presence of strong electric fields and discharges within the dielectric rocks of the Earth's crust.

Diatremes (channels from the Earth's interior) are the result of subsurface electrical discharges, their explosive effects, the mechanical fluctuations of rock destruction under conditions of strong electrical fields (>104 V/cm), and the melting of channel walls. The melting of the rocks produces hot gases (possibly plasma), which escape from the Earth's upper mantle at great velocity, destroying the tops of the channel and forming explosive, funnel-like craters.

Molten magma then ascends the channel behind the plasma.

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Geological Consequences of Large Meteoric Bodies Approaching the Earth – The Electrical Factor

Cont. from page 21

According to Vorob'yev [op cit] these electrical processes and the electrical explosions are a possible explanation of the formation of pipes and some ring structures. This research was continued by Stepanov [4] and Balasanyan [5]. They suggested that the power of electrical discharges in the Earth's crust, with their energy concentrated in a small area, is sufficient to form explosive structures. The conclusion drawn by Balasanyan [5] is worth noting: ***A necessary condition for electrical discharges in the Earth's crust acting like a trigger is a sharp increase of negative charges on the Earth's surface affected by atmospheric electricity.***

Group 2. Meteoritic bodies (MBs) as sources of electric fields

Astapovitch and Solyanik [6, 7] considered the process of accumulation of positive charges on the surface of MBs moving through the Earth's atmosphere. MBs induce negative charges on the Earth's surface within zones of influence called "tension spots", in the same manner as thunderstorm clouds. Solyanik [7] and later Nevskiy [8] made calculations that showed electrical discharges between MBs and the Earth's surface are possible. Both of them suggest, for example, that the explosion of the famous Tunguska body was caused by electrical discharges. For a long time these explanations did not gain support in scientific circles, and only recently have they started to attract attention.

These data are well known by specialists in the field of electrophonic fireballs, but have still to be recognized by geologists. Data that have been accumulated point to the influence of the energy of MBs on objects on the Earth, including the following:

(i) People and animals exhibit signs of fear and a sense of danger (before observing MBs).

(ii) Damage to TV, electrical and radio equipment, bulbs catching fire in switched-off electric networks, formation of St. Elmo's lights, e.g. during the time the Chulym and Vitim fireballs passed over Siberia in February 1984 and September 2002 respectively.

(iii) Activation of seismic processes.

The effects identified in (ii) above form the basis for supposing that the main causes of the energy influence are electric (i.e. electromagnetic) fields. All of these effects were observed in connection with the appearance of small MBs (approximately 1 to 40 meters in diameter) that burned or blew up in the atmosphere. Imagine the scale of the effects that might occur if the MB entering the Earth's atmosphere was a huge asteroid more than one kilometer in diameter.

Group 3. Structural independence of diatreme zones and fields

Analysis of the distribution patterns of diatreme zones and fields reveals a common independence relative to the crustal structure, including the magma controlling faults described by various authors [9-13 and many others]. For example, the well-studied Markha-Olenek kimberlite zone, with a length of about 750 km, shows no spatial-genetic connections with major structures of the northeastern Siberian platform (pre-Vendian faults, relief of crystalline basement, main fold structures of the cover, and basite-controlling zones) [9].

The recognition of this structural independence led to the idea of their origin in terms of a "hot spot" by Zhitkov [14]. This hypothesis has now received serious acknowledgement in the east of the USA by Heaman and Kjarsgaard [15]. However, as the quoted authors note, it is not universal and is not applicable to kimberlite fields elsewhere in North America. Besides, it can't explain the deficiency of magmatic melt in the diatremes that is the main distinctive feature of those structures.

Group 4. Spatial-temporal connections of ring explosive structures and diatreme fields and zones

Bucher [16] was the first to pay attention to the spatial-temporal connections of some ring explosive ("cryptovolcanic") structures on the one hand, and diatreme fields and zones on the other. He illustrated this with some examples from the USA and Germany. His ideas were developed later in the publications of Vaganov et al. [17], Nicolayesan and Fergusson [18], and many others. The most convincing argument for the relative connection of these structures are the ring explosion structures of Ries (24 km in diameter) and Steinheim (3 km) in southern Germany. These structures are along the same straight 100-kilometer-long line as the explosive pipe field Urach. The K-Ar age of these formations are identical, namely 14.8 Ma.

Khazanovitch-Wulff [19a] gave other examples of the spatial connection between diatreme fields and ring structures. In particular, the above-mentioned Markha-Olenek kimberlite zone (~365 Ma) forms the "train" of the large Olenek ring structure with a diameter 250 km (D3). The author also knows of eight examples in North America, three examples in Europe, five examples in Asia (including three with alkaline massifs on astroblemes), three in Africa and four in Australia – a total of 23 so far. It is thought that further detailed analysis of the geological structure of continents should result in the discovery of more occurrences of this type.

Bucher and his followers have used some of these examples as evidence of the endogenic (non-meteoritic) origin of ring explosive structures but as there is conclusive evidence for the meteoritic origin of some of these structures, how can these be explained?

The following mechanism, initially proposed by [19a], links the four main groups of data into one logical chain, by the addition of one extra factor – electricity.

Consider the entry into the Earth's atmosphere of large MBs accompanied by the accumulation of electrical charge on their surface that induces a zone of electrical "mirror charge" or tension spot, on the Earth's surface. This electrical tension spot moves with the MB along its projected trajectory and may even lead it.

This tension spot is the "driving force" of the geoelectrical activity in the Earth's crust and upper mantle.

In areas with a strong electrical field in the Earth's crust or upper mantle, diatreme fields or earthquakes could be triggered when the electric discharges either reach or fail to reach the Earth's surface

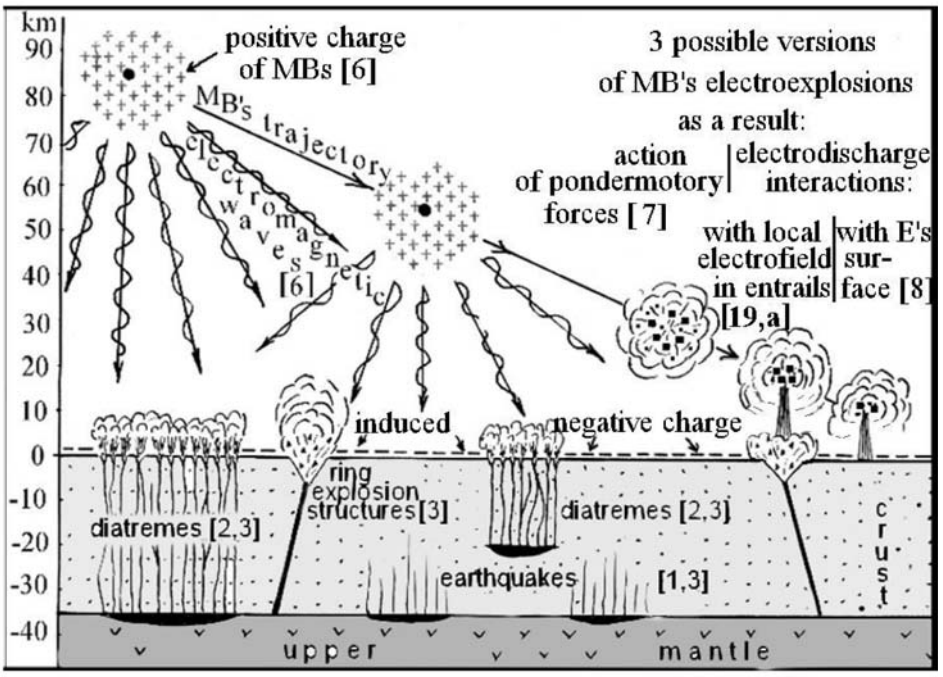

Figure 1. Main events in the Earth's atmosphere and lithosphere associated with intruding large MBs (diameter >1 km?). Black lenses – zones of strong, localized electric charge. Black bold vertical lines in the crust – faults with strong electric fields. Thin vertical lines – channels of electrical discharges associated with magma (diatremes) or internal short circuits (earthquakes) from failure to reach the Earth's surface.

respectively (Figure 1). In both cases, if the MB accumulates an extremely large electrical charge or reacts electrically with the Earth, then it can be destroyed by the electrical stresses produced by the encounter. The Tunguska and Sikhote-Alin events are possible examples of such explosions.

Therefore the Urach diatreme field could also be interpreted as a "diatreme train" of a large MB which was split into two parts by electrical stresses. The smaller part formed the Steinheim crater and the larger one, the Ries crater.

Naturally, the flight trajectory of an MB in the Earth's atmosphere is independent of geological structures in the area and could explain the random geological position of diatreme fields and zones on the Earth's crust.

Ring explosive structures can form in at least two ways. Firstly, as the result of the interaction between high electric fields induced by an MB and zones of accumulations of electric charge in the Earth's crust (for example, zones of deep faults). Examples of these structures are Zhamanshin (Kazakhstan) and Ternovskaya (Ukraine), centered on deep faults that cannot be regarded as impact fractures of a cosmogenic body [19b].

Secondly, as a result of the MB's impact with the crust. In both cases, the reasons for the spatial-temporal connections between the diatreme "trains" and ring explosive structures are clarified by this MB electrical link.

It has been noticed that not all diatreme fields have associated astroblemes and vice versa. There are several possible explanations.

(i) In some regions with a large cover of surface glacial deposits (for example, Canada and northwestern Russia),incomplete geological knowledge may mean that existing associated diatreme fields and astroblemes may not yet have been identified.

(ii) In some cases, it is possible that no electric discharge occurred between the Earth's lower crust and the Earth's surface. For

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Geological Consequences of Large Meteoric Bodies Approaching the Earth – The Electrical Factor

Cont. from page 23

example, if the MB had a near vertical trajectory there might have been no time for a large charge to accumulate or there may have been no zones in the Earth's crust inside the MB's tension area with electric fields strong enough to cause an electrical discharge to the Earth's surface. In this case, "underdeveloped" explosion structures could form inside this area, for example Stopfenheim dome northeast of the Ries crater, Hatzium Dome inside the Gibeon kimberlite and meteorites, Namibia [19c], and others.

(iii) A diatreme field without an associated astrobleme may be the result of an MB which accumulated its maximum possible charge before impact but was destroyed in the atmosphere as a result of internal electrical stresses.

(iv) In uplifted districts astroblemes could be completely eroded while the roots of the diatremes connected with them could remain.

Additional new information shows that not only MBs, but even aircraft, may produce seismic activity in certain districts. In 1992, re-entry of the Space Shuttle into the Earth's atmosphere produced seismic signals that were recorded by the Washington RSN and described by Qamar [20].

Conclusion

Thus, the geological consequences of the interaction between large MBs with the Earth are not limited to mechanical impact, but may also result from electrical stresses in the atmosphere and the Earth's crust, producing seismicity, local partial melting of the mantle and the eruption of kimberlites to the Earth's surface. ▲▲

References:

1. Finkelstein, D. and Powell, J. (1971) XV Gen. Assembly Int. Union of Geodesy and Geophisics, Moscow, part 8, 35.
2. Alekseevsky, K. and Nikolaeva, T. (1972) Journal "Znaniye-Sila", N. 4, 30.
3. Vorob'yev, A.A. (1975) Physical Factors Governing the Occurence and Properties of Plutonic Material: Strong Electrical Fields in the Earth's Interior (in Russ.), Tomsk University Press, 296p.
4. Stepanov, O. (1989) Sov. Geol., No. 12, p. 95-104.
5. Balasanyan, S. (1990) Dynamic Geoelectric Theory (in Russ.), Nauka Press, Novosibirsk, 232p.
6. Astapovitch, I.S. (1958) Meteoric phenomena in the Earth's atmosphere (in Russ.), Fismatgiz, 640p.
7. Solyanik, V.: a) (1959) Yuniy Tehnik, N. 3, p. 64-65; b) (1980) Vzaimodeystviye meteoritnogo veschestva s Zemlyoy. Novosibirsk: Nayka, 178-188.
8. Nevskiy, A. (1978) Astronom. Vestn., No. 5, p. 206-215.
9. Brakhfogel', F.F. (1984) Geological Aspects of Kimberlite-Igneous Activity in the Northeast of the Siberian Craton (in Russ.), Yakutsk, 128p.
10. Milashev, V. (1984) Explosion pipes (in Russ.), Nedra Press, 284p. [11]
11. Vladimirov, B.M., et al. (1990) Kimberlites and Kimberlite-Like Rocks (in Russ.), Novosibirsk: Nauka, 264p.
12. Mitchell, R.H. (1986) Kimberlites: mineralogy, geochemistry, and petrology. NY, 442p.
13. Skinner, E.M., et al (1992) Geol. and Geophis., No. 10, p. 33-40 (in Russ.).
14. Zhitkov, A.N. (1995) Extended Abstracts of 6-th International Kimberlite Conference. Russia, p. 692-694.
15. Heaman, L.M., Kjarsgaard, B.A. // EPSL, 178 (2000), p. 253-268.
16. Bucher, W.H. (1963) Am. J. Sci, vol. 261, No. 7, p. 567-649.
17. Vaganov, V.I., Ivankin, P.F., Kropotkin, P.N., et al. (1985) Explosive Ring Structures of Shields and Cratons (in Russ.). Nedra Press, 200p.
18. Nicolayesen, L. and Fergusson, J. (1990) Tectonophysics, vol. 171, No. 1/4, p. 303-335.
19. Khazanovitch-Wulff, K.K.: a) (1991) Transactions of USSR Academy of Sci., Earth Sci. Sections, vol. 320, No. 7, p. 127-131; b) (1994) Doklady Akad. Nauk, vol. 337, No. 1, p. 83-87; c) (2001) Abstracts of the 64-th Annual Meteor. Soc. Meeting, 78.
20. Qamar, A. (1993) Seismol. Research Lett., vol. 64, No. 1, p. 46.

Hydrocarbon Heresy: Rocks into Gas

(Harvard Magazine)

GEOLOGISTS HAVE LONG believed that the world's supply of oil and natural gas came from the decay of primordial plant and animal matter, which, over the course of millions of years, turned into petroleum.

But new research coauthored by Dudley Herschbach, Baird research professor of science and recipient of the 1986 Nobel Prize in chemistry, questions that thinking. Published last fall in the *Proceedings of the National Academy of Sciences*, the study describes how investigators combined three abiotic (non-living) materials – water (H_2O), limestone ($CaCO_3$), and iron oxide (FeO) – and crushed the mixture together with the same intense pressure found deep below the earth's surface. This process created methane (CH_4), the major component of natural gas. Herschbach says this offers evidence, although as yet far from proof, for a maverick theory that much of the world's supply of so-called fossil fuels may not derive from the decay of dinosaur-era organisms after all.

Herschbach became interested in the origins of petroleum hydrocarbons while reading *A Well-Ordered Thing*, a book about the nineteenth-century Russian chemist Dmitri Mendeleev, who developed the periodic table. Written by Michael Gordin '96, Ph.D. '01, a current Junior Fellow, the book mentions a theory long held by Russian and Ukrainian geologists: that petroleum comes from reactions of water with other abiotic materials, and then bubbles up toward the earth's surface.

Intrigued, Herschbach read further, including *The Deep, Hot Bio-sphere* by the late Cornell astrophysicist Thomas Gold. An iconoclast, Gold saw merit in the Russian and Ukrainian view that petroleum has nonliving origins. He theorized that organic materials found in oil – which most scientists took as a sign that petroleum comes from living things – may simply be waste matter from microbial organisms that feed on the hydrocarbons generated deep in the earth as these flow upward.

Another of Gold's assertions about methane and oil really caught Herschbach's attention. "He said there wasn't much chance that you could do a laboratory experiment to test this," Herschbach reports. "And I thought, 'Holy smoke! We could do this with the diamond anvil cell.'" Long interested in how molecules behave under high-pressure conditions, he contacted Russell Hemley, Ph.D. '83, a former student now at the Geophysical Laboratory at the Carnegie Institution of Washington, to suggest the methane experiment. Together with Henry Scott of Indiana University and other researchers, Herschbach sought to create the same conditions found 140 miles below the earth's surface, where temperatures are scorching and pressures mount to more than 50,000 times those at sea level. "It's a great pressure cooker," he explains.

For Herschbach, these exciting research questions have "given me a second scientific childhood." He and his colleagues are eager to return to the lab and find out if even higher pressures will create more complex hydrocarbons, such as butane or propane. The research raises fundamental questions about how scientists determine if a material has living or nonliving origins. It also validates the work of previous scientists. "The fair conclusion," Herschbach says, "is that the views of Thomas Gold and Russian scientists all the way back to Mendeleev need to be taken more seriously than they have been in the Western world." ▲▲

Proposal to Merge NOAA and US Geological Survey to Form an Earth Systems Science Agency

SCIENCEDAILY (JULY 3, 2008) — In an article published in the journal Science, a group of former senior federal officials call for the establishment of an independent Earth Systems Science Agency (ESSA) to meet the unprecedented environmental and economic challenges facing the nation. They propose forming the new agency by merging the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS).

Charles Kennel, former Associate Administrator of the National Aeronautics and Space Administration and Director of Mission to Planet Earth, says, "Earth system science focuses on understanding current processes and predicting changes that will take place over the next hundred years. It merges earth, atmospheric, and ocean science into a panorama of the earth system as it is today and as it will be tomorrow. We need it to predict climate change and its impacts, and to help us mitigate and adapt to other changes that have the potential to affect our quality of life and economic well-being."

The article points to the many scientific advantages of linking the atmospheric and marine programs of NOAA with the terrestrial, freshwater, and biological programs of USGS. Former NOAA administrator D. James Baker and former USGS director Charles Groat, among the seven coauthors of the paper, see important synergies in linking the two agencies.

According to Baker, "Population pressure, development impact, and resource extraction affect land and sea alike. Just as the science of the Earth is seamless, so should the government responsibility be merged for these separate Earth agencies."

Groat points to the breadth of capabilities the agency would possess. "The USGS, in bringing not only its geologic, biologic, hydrologic and geospatial expertise to the understanding of natural systems, but also its research capabilities in energy, mineral, water, and biologic resources, gives the new organization a comprehensive perspective on both environmental and resource systems. If we effectively link these capabilities with those of NOAA, we will have a powerful research institution," he says.

The authors express concern that federal environmental research, development, and monitoring programs are not presently structured to address such major environmental problems as global climate change, declines in freshwater availability and quality, and loss of biodiversity.

According to Donald Kennedy, former commissioner of the Food and Drug Administration and past president of Stanford University, "It isn't often that we are offered a real opportunity to make government work better. But the modest, sensible reorganization proposed here brings a new science-rich focus on some of our biggest contemporary challenges."

Kennedy also stresses the importance of linking ESSA's activities with the tremendous talent in the nation's universities.

The authors recommend that no less than 25 percent of the new agency's budget be devoted to grants, contracts, and cooperative agreements with academic and nonprofit institutions. ESSA's success will also hinge on the collaborative arrangements the agency makes with other federal departments and agencies. According to former presidential science adviser John H. Gibbons, "ESSA's effectiveness will depend upon the bridges it builds to other federal agencies, from the National Aeronautics and Space Administration and National Science Foundation, to the Department of Energy and U.S. Environmental Protection Agency."

David Rejeski, who worked in both the White House Office of Science and Technology Policy and the Council on Environmental Quality, emphasizes the importance of setting aside some of ESSA's budget to fund research and development with breakthrough potential. "The Defense Advanced Research Projects Agency has demonstrated the value of funding high-risk, high-reward research and development. ESSA should foster similar ventures in the environmental arena," Rejeski says.

The paper points to the direct link between research and development and economic growth. The work of NOAA and USGS already fuels a large, multi-billion dollar private sector enterprise.

Mark Schaefer, a former official at the Department of the Interior and the White House science office, adds that "the quality of life of future generations will be defined by the quality of the environment we hand down to them. Our nation's research and development enterprise must be better structured and directed if we are to have any chance of solving the tremendous environmental challenges of our time." ▲▲

AIG Organises Successful Student Career Night in Perth

TWENTY YEAR 10, 11 & 12 STUDENTS representing Kent Street Senior High School and other senior schools as well as 90 University students from WA and elsewhere, attended the Australian Institute of Geoscientists Student Career expo at the Perth Exhibition Centre. The expo formed part of the 2008 Australian Earth Science Convention, an event that occurs once every 20 years in Perth.

The students networked and asked questions of various professionals from some 14 different minerals and energy companies that have operations in Western Australia and throughout the world — Independence Group, Rio Tinto, BHP Billiton, Woodside, Shell, TeckCominco, Heron Resources, Portman and Hancock Prospecting — just to name a few. The students became more familiar with the array of job/career opportunities that are available to them after they graduate. They asked about scholarships, summer vacation employment prospects and company operations and management strategies.

Most importantly the school students developed a lot of self confidence by the end of the night as they modified their own questioning strategies to obtain information about the company or employment prospects. They got so excited when through their networking they managed to secure contacts, getting emails, names and telephone numbers useful for gaining vacation employment.

Other highlights of the night included a meeting with the Chief Scientist of WA — Professor Lyn Beasley and not to mention the filling of show bags with lots of goodies from the 80 or so stalls advertising at the convention. School students were acknowledged for their polite manners and dress. It was a successful evening and one that benefited them in their endeavour to create greater self awareness of the career opportunities available to them in the field of geosciences.

The previous careers expo encouraged five Kent Street Senior High School students to go on to university to study geoscience. The organisers hope that this year's expo has a similar impact.

Suzy Urbaniak-Wright
Earth & Environmental Science Teacher

Top: Kent Street Senior High students with WA Chief Scientist Dr Lyn Beasley at far left and Suzy Urbaniak next left.

Above: Bill Amann talking to students

Above: Marcus Harris MC-ing the night

Left: Young professional Alex Hewlett (CSA Global) addressing students on career opportunities

Photos: Clark Rodda of Festival City Photography

2008 Student Careers Sponsors

Education Report

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These bursaries are offered to geoscience students at South Australian Universities.
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(General eligibility criteria and guidelines also apply.)

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AIG Student Bursary Program

Applications for the 2008 bursary program closed on the 18th July and, at the moment, the Education Committee is reviewing the applications received. This year we received a near-record number of applications, with 30 applicants from 12 universities, and we would like to acknowledge the support of the many university academics who circulated bursary application forms to their students. Future issues of AIG News will include abstracts from some of this year's applicants and in this issue we include abstracts from two 2007 bursary winners:

- **Thomas Raimondo**
  — awarded a 2007 PIRSA-AIG Honours Bursary, and
- **Catherine Loye**
  — awarded a 2007 Kagara-AIG Honours Bursary.

Both Thomas and Catherine were students at Adelaide University.

Teacher Earth Science Education Programme (TESEP)

The TESEP program, to promote Earth Science teaching in secondary schools in the eastern states, will began delivering workshops to secondary teachers this month (August). The first workshops will be held in Queensland — in Biloela and Brisbane.

TESEP is being run under the umbrella of the Australian Science Teachers Association and is funded by support from geoscience organisations (including the AIG) and from industry. The programme has received sufficient support to get underway but is in need of additional funds to ensure its continuation for the next two years. At the time of writing the programme had not received any support from mineral resources companies. If your organisation or company is interested in supporting this programme please contact the Chair of the Advisory Board, Jill Stevens (jill.stevens@exxonmobil.com), or the Executive Officer, Greg McNamara (geoservices@geoed.com.au).

GeoEdLink

The next issue of GeoEdLink, the Australian Geoscience Council geoscience education e-newsletter, will be circulated in August. If you would like to subscribe to the newsletter simply put the word subscribe in the subject line and send an email to agc_edlist@geoed.com.au with no words in the body of the email.

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ABSTRACT: The tectonic reworking of the southern Vestfold Hills, East Antarctica

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Abstract

The Archean basement of the Vestfold Hills, East Antarctica was pervasively intruded by numerous dyke phases during the middle to early Proterozoic and preserve evidence of later tectonic reworking. Sm-Nd analyses from the youngest undeformed yet recrystallised garnet bearing tholeiite dyke yields 734±8 Ma confirming that the metamorphic overprinting occurred during the breakup of Rodinia. Field observations and detailed examination of the petrological relationships, mineral composition analyses obtained from an electron microprobe, thermobarometric calculations using THERMOCALC software and investigation of previous geochronology of the youngest dyke have revealed that: (i) the minimum age of intrusion of the youngest dyke is 950±47 Ma, (ii) the age of the metamorphic overprint is 734±8 Ma coeval with the breakup of Rodinia, (iii) the physical conditions of metamorphism were ~750?C and 10kbars, (iv) metamorphism was not accompanied by deformation and (v) the compositional homogeneity of garnet reflects that the post metamorphic cooling was rapid. These parameters lead to the interpretation that the recrystallisation occurred as a result of contact metamorphism. 2D thermal modelling of mafic intrusions indicate existence/previous existence of a small, 1-5 kilometre scale sill proximal above or below the present day exposure of the youngest dyke. The tectonic reworking resulting from the magmatic intrusion into the deep crust occurred in response to extension related magmatism during the breakup of Rodinia in the mid-Neoproteroizoic. ▲▲

ABSTRACT: A kinematic, metamorphic, geochemical and geochronological framework for intracratonic reworking in the western Musgrave Block, central Australia

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Abstract

The crustal architecture of central Australia has been profoundly affected by periods of intracontinental deformation. Within the western Musgrave Block, Western Australia, the Neoproterozoic to Early Cambrian (600-520 Ma) Petermann Orogeny resulted in pervasive mylonitic reworking of Mesoproterozoic granites and granitic gneisses at deep crustal levels (P = 10-13 kbar and T = 700-780°C). SHRIMP and LA-ICPMS analysis of zircon and titanite indicate that peak metamorphic conditions were attained at c. 570 Ma, followed by progressive cooling to c. 600-660°C by c. 540 Ma driven by exhumation along the Woodroffe Thrust. A slight increase in average geothermal gradients moving south of this location suggests that deeper crustal sections experienced more rapid exhumation. This is supported by good correspondence between the record of thermal equilibration retained by equilibrium mineral assemblages and the crystallisation conditions of zircon and titanite identified using Ti and Zr thermometry. Shearing conditions during deep crustal mylonitisation appear to be dominantly anhydrous, although evidence of fluid influx into discrete shear zones is indicated by solid-state zircon recrystallisation and relatively hydrous mineral assemblages. This suggests a complex pattern of fluid partitioning and limited structural connectivity between mylonitised domains. At the outcrop scale, the correlation between distinctive structural expressions and strain intensity is interpreted to represent the simultaneous development of pure and simple shearing, resulting in the progressive partitioning of coaxial and non-coaxial strain components into discrete rock packages. This has implications for the genetic interpretation of lineations that plunge at oblique angles to the predominant regional orientation. At the orogenic scale, the relationship between kinematic partitioning and an anomalous lobate geometry of the Woodroffe Thrust trace suggests that north-directed emplacement of a broad thrust sheet was accompanied by southwest-directed lateral extrusion driven by gravitational collapse. This is indicated by the rotation of regional lineation patterns from orogen-parallel adjacent to the approximately linear fault trace to highly oblique at the point of greatest curvature further west, representing a change in the trajectory of material flow caused by lateral escape towards the orogen margin. Pervasive extensional deformation was thus produced in the hanging wall of the Woodroffe Thrust whose kinematic polarity is decoupled from the bulk tectonic transport of the Petermann Nappe Complex. ▲▲

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Dr. Oliver Kreuzer, of Rockingham, W.A., in Mineral Exploration

Mr. Volker Gartz, of Rossmoyne, W.A., in Mineral Exploration

Mr. Timothy Rowles of West End, Queensland, in Environmental Geoscience and Geotechnical Engineering

NEW CANDIDATES PUBLISHED FOR PEER REVIEW BY THE MEMBERS OF THE AIG

Mr. Justin Legg of Petrie, Queensland, in the field of Mineral Exploration

Mr. Fergus O'Brien of Lawnton, Queensland, in the fields of Mineral Exploration and Regional Geology

Ms. Wendy McLean of Sydney, NSW, in the fields of Hydrogeology and Geochemistry

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New Members and Upgrades at the May and July Council Meetings 2008

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We welcome all new members to the AIG.

AIG FEDERAL COUNCIL FOR 2007-2008

AIG NEWS

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