LAVA NEWS

MERRY CHRISTMAS 2000 EDITION

THE BASALT COLUMN

Seasons Greetings! Welcome to the "new look" LAVA. Well, this newsletter may not seem much different given the familiar LAVA logo, but behind the scenes much has changed. At the 15th AGC in Sydney (3-7 July, 2000), the inaugural LAVA committee handed over the reigns to a new committee. Sharon Allen (UTas) and Liz Jagodzinski (AGSO) now jointly chair LAVA. Both of us were targeted as prime candidates as we are strongly involved in volcanological research in South Australia, which is the host State for the 16th AGC (Adelaide 2002).

I'm sure I speak of behalf of all LAVA members of our appreciation for the two years of pioneering work that Lis Arundell (President), Carol Simpson (Secretary), Leah Moore (LAVA editor) and Kelsie Dadd (web site manager) along with their committee members have devotedly put into LAVA. They have done a fantastic job in gathering more than 70 Australian volcanologists together for this specialist group. Evidence for the interest in our research was exhibited by the well attended technical sessions at the AGC in Sydney. In addition, the LAVA newsletter, has kept us exceptionally well informed both nationally and internationally of current volcanological research, meetings and publications. On behalf of all the members of LAVA we wish you all well for the future.

Lis Arundell is remaining on the committee as immediate past president, and is also the current treasurer. She is responsible for the smooth running of LAVA through this transition period of a new committee. Ian Roach has taken on the task as editor for LAVA. Thank you to all those who responded to his call for contributions. The LAVA newsletter is the most instrumental means we have for providing a forum to discuss issues and to learn about the kinds of volcanological research being undertaken in, or from, Australia. In each LAVA issue we would like to feature current research from one or more of our States/Territory. Since I was not successful in delegating this job to another committee member, the feature of this LAVA newsletter is University of Tasmania. In addition, there is a new section in LAVA News for recent publications. These sections will allow us to keep up to date on current research and results.

To aid the gathering and dissemination of information for LAVA the remainder of our committee includes representatives from each State/Territory. They are:

- Scott Bryan, University of Queensland,
- Ceinwen Scutter, Monash University,
- Stuart Brown, University of Western Australia, and
- David Rawlings, Northern Territory Geological Survey.

Unfortunately, we have no representative for NSW, please let us know if you would like to take on this position.

Wishing you all the best for 2001,

Sharon Allen
co-chair, LAVA

FROM THE EDITOR

Dear LAVA members and other readers. Welcome to this third BUMPER LAVA News. In this issue you will notice that I have broadened the term "volcanology" to include geochemistry, landscape evolution and even neo-tectonics as they relate to the subject. This issue includes articles on volcanic hazard management in the south-west Pacific, peperites, pumices, geotourism, active volcano monitoring, leucitites and landscape evolution, neotectonics in lava fields and Tasmanian dolerites. These contributions are but a small part of "volcanology" within and without Australasia. We also have all the usual conference reports and information, ads, pleas and a new section (**New A'articles**) that features recent and "in press" publications by Australasian volcanologists.

I would like to engender a sense of belonging to the LAVA specialist group by publishing *LAVA News* twice yearly, unlike some other GSA specialist groups (which shall remain nameless) that take your $5 (+ 50c GST) but don't deliver. We are also now inviting all students, academics, professionals and laypersons to contribute. They may not necessarily be payed-up LAVA members but they are still contributing to the wealth of knowledge about "volcanology" in its many guises. We also aim to publish a feature article about one Australasian volcanological research institution per issue—this time, the University of Tasmania and CODES.

So, sit back, make a cup of your favourite beverage (or have a strong drink), loosen your clothing, and enjoy reading volume 3 of *LAVA News*.

A MESSAGE FROM THE PRESIDENT, GSA

Dear Members,

Many of you will already be aware of two very important reports which have been issued under the auspices of the Federal Department of Industry, Science and Resources in the last month. First a discussion paper by the Chief Scientist, Dr Robin Batterham, titled 'The Chance to Change' that deals with Australia's Science Capability and makes recommendations as to how this can be improved (available at http://www.isr.gov. au/science/review). Second, the final report of the Innovation Summit Implementation Group (available at http://www.isr.gov.au/industry/summit/isig/body_isig.html).

Although there are particular aspects of the reports that would benefit from greater emphasis on the Earth Sciences, which the Society will indicate in formal letters from the Executive and through a submission from the Australian Geo-science Council, their main thrust is very positive. Both recommend millions of new dollars for R&D and Science, Engineering & Technology.

In order for the recommendations in the reports to be accepted by the Government and appropriately funded, it is vital that Senator Minchin as Minister for Industry, Science and Resources receives a very clear message from the scientific community as to our support for the recommendations and how important their implementation will be to Australia remaining competitive in the global economy.

When the Wills report into Health and Medical Research was released for comment over 2000 individual submissions were received and these are seen as having been a major determinant in having the recommendations of that report adopted. Scientists, including geoscientists, must not let the present opportunity be lost but emulate our medical colleagues.

I strongly encourage all GSA members to send a short message supportive of the broad thrust of the two papers. Comments on the Batterham report should be sent to S.Clough@isr.gov.au and regarding the Innovation Summit Implementation Group Report (or a comment relating to both reports) to Senator Minchin at senator.minchin@ aph.gov.au.

Please encourage all scientists with whom you interact to consider likewise indicating their support. There is currently a unique opportunity to press the Federal Government for a major increase in funding across all sectors involved in research and development and we must make the most of it.

Sincerely,

Evan Leitch
President
Geological Society of Australia
(evan.leitch@uts.edu.au)

LAVA AT THE AGC

Jocelyn McPhie
LAVA Member, CODES

LAVA, the recently created specialist group for Australasian volcanologists, held its first technical session on “Volcanic facies and processes” at the 15th Australian Geological Convention in Sydney. There were seven oral presentations and two posters. The papers on diverse topics included contributions from Sharon Allen and Jocelyn McPhie, both at CODES at the University of Tasmania, Carol Simpson and Liz Jagodzinski, both at Monash University, and Leah Moore, University of Canberra. The session was very well attended with the audience overflowing into the aisles and corridor, and participating in the discussions that followed the formal presentations. During the convention, LAVA members met and elected new leaders. Sharon Allen (CODES) and Liz Jagodzinski (AGSO, seconded to PIRSA in Adelaide) have taken on the task. The choice is most appropriate, given the plan to hold the next AGC in Adelaide. Both Sharon and Liz are working in the Gawler Range Volcanics in South Australia and will be well placed to convene technical sessions on volcanology and to offer a volcanological fieldtrip.

INTERNATIONAL MAAR CONFERENCE 2000

Mark Bishop
LAVA Member, University of South Australia

During August 2000 the first 'International Conference on Maar Volcanism' was held in the classic and picturesque Eifel district of West Germany. I was fortunate to attend the pre-conference field trip that concentrated on the maars in the SE part of the West Eifel. Many of the classic textbook sites were seen and discussed. Volker Lorenz (tour leader) focused on discussing ideas about the tephra and its characteristics, the processes of tephra formation, phreatomagmatic explosion styles in the root zones of maar-diatremes, and the growth of maar craters and underlying diatremes. This was an opportunity to see and discuss ideas on the architecture and formation of maars both in the Westeifel, and for me, those of the Newer Volcanic Province and Mount Gambier sub-province of southeastern Australia. The spatial relationship between stream valley floor and maar landforms typifies the Westeifel region and was a stunning contrast to the distribution of scoria cones and maars across the plains units of Victoria.

To say the least, the field trip was one of the best-organized, informative and entertaining geological events that I have attended. What immediately comes to mind about this trip, besides the fantastic geology and geomorphology, was the hospitality of the hosts (V. Lorenz, F.O. Neuffer, H.Lutz and B. Zimanowski). As if the setting wasn't special enough, the lunches must have clinched the 5-star award for field trips. Each day, students set-up tables and benches under umbrellas and served oodles of hot soup, sausage, salad, dessert and hot and cold beverages—now I understand what postgraduate students are for. Ken Wohletz summed up the after lunch feelings when he stated, "that the hardest thing we've done all day is try to get off the bus". However, the most appreciated addition to the trip was what became known as the 'last-outcrop beer' – need I say more.

Following the field trip to the Westeifel, the conference ran parallel sessions regarding the architecture and formation of maars (experiments and modeling), maar lake sediments (stratigraphic and climatological records) and the palaeontology (taphocoenosis and biostratigraphy) and hydrogeology (maar formation and procurement of water) of maar volcanoes. Overall, the presentations both oral and poster, were excellent, and brought together at the one locality the many sub-disciplines concerned with the study of monogenetic volcanism. The poster presentations, in particular those of post-graduate students from the host Universities, were outstanding and displayed the interest in both monogenetic volcanic processes and landform origin and evolution. Another notable achievement proudly highlighted at this conference, was the involvement of both professional volcanologist and local community in geo-tourism throughout the Eifel district. Local communities, Daun, Gerolstein and Mandersheid are each widely involved and compete in the establishment of maar museums, Geo-Parks for geo-tourism and environmental education, and the public awareness of earth processes and regional landscape evolution. Much could certainly be learnt from these communities here in Australia with regard to Museum and public awareness programs about volcanism. It was evident to all attendees that successful education about earth processes need not concentrate on the typical spectacle of shield and strato-volcanoes as it often does.

The keynote papers presented by Michael Ort on the past and current research of the Ukinrek maars, Grant Heiken's review of the historical figures involved in hydrovolcanic studies, the physical volcanological discussions on maar-diatreme models by Volker Lorenz, James White's review of the Hoppi Buttes, and Ken Wohletz's past and current work on water-magma interactions again indicated the spectrum of disciplines involved in the study of phreatomagmatism. It was obvious from this meeting that the study and interest in maar volcanism and monogenetic systems as a whole, is far from complete, and that a plethora of research opportunities await future students.

Overall, one would find it near impossible to fault the quality of the research papers, and standard of the First International Maar Conference. All participants conceded that it would be near impossible to equal, let alone better the standards reached by our German hosts. It was hoped that this was not the first and last conference dealing with maar volcanism, with the hosts very suggestively indicating that both North America and Australia be the next conference venues. I am certain that the members of LAVA would also welcome and assist in organizing such a prestigious event in the not too far future.

VOLCANOLOGICAL RESEARCH AT THE UNIVERSITY OF TASMANIA

Sharon Allen
LAVA Co-chair

Volcanological research at the University of Tasmania is led by Jocelyn McPhie. Core projects within the volcanology program of the Centre for Ore Deposit Research Special Research Centre focus on the facies architecture of submarine successions that host massive sulfide ore deposits, primary and alteration textures in volcanic rocks and development of facies models for volcanic successions in porphyry Cu-Au districts. This research has mostly been the focus of several PhD Students. These include:

- Steve Hunns: Volcanology and volcanic facies architecture and associated mineralisation in the Early Permian Beserker beds, central Queensland
- Cathryn Gifkins: Subaqueous silicic volcanics in the Mt Black Volcanics, western Tasmania
- Karin Orth: Style and setting of massive sulfide mineralisation at Koongie Park, Halls Creek, Western Australia
- Kirstie Simpson: Volcanic facies architecture of the Mt Windsor Volcanics, Queensland
- Alison Raos: Volcanological-petrological evolution of Efaté Island, Vanuatu
- Sarah Jones: Geology and geochemistry of the 'cap rocks' and hangingwall lithologies overlying the Myra Falls VHMS deposits, Canada
- Andrew Stewart: Volcanic facies architecture of a Quaternary, mineralised, island-arc volcano; Milos, Greece
- Rick Squire: Geological and metallogenic evolution of the Ordovician Rockley-Gulgong Belt, New South Wales
- Michael Agnew: Volcanic setting of massive sulfide mineralisation at Lewis Ponds, NSW
- Andrew Jones (MSc): Volcanology and geochemisty of the Cambrian Mt Read Volcanics of the Basin Lake area, western Tasmania

Andrew Jones and Steve Hunns submitted their theses this year, and Cathryn Gifkins, Kirsite Simpson, Karin Orth and Alison Raos are near completion. Both Rick Squire and Sarah Jones are also on track to complete their PhD's during 2001 and Andrew Stewart commenced his PhD this year.

An ARC Large Grant to Jocelyn McPhie

and logistical support by Mines and Energy, South Australia has funded further research on the Gawler Range Volcanics (South Australia). This work has involved two research fellows, Sharon Allen and Carol Simpson. The Gawler Range Volcanics is one of the largest known and best preserved ancient intraplate felsic provinces in the world. They include several widespread felsic units that have textural features that most resemble lavas and lack pyroclastic textures generally associated with ignimbrites (*there is an article on the Gawler project later in this issue - Ed.*).

Two researchers have been successful in gaining Post-Doctoral Research Fellow- ships: Kirstie Simpson is moving to Trinidad and Tobago, and Sharon Allen has an ARC fellowship to remain at UTas. Sharon will be using experimental simulations combined with textural analysis of submarine volcaniclastic mass flow deposits that result from large-scale eruption and failure events to characterise the origins of these deposits.

Jocelyn McPhie together with Ian Skilling (University of Southern Mississippi, USA) and James White (Otago University, NZ) are editors of a special issue in Journal of Volcanology and Geothermal Research on Peperite due to appear in 2001. The need to define "peperite" developed from a technical session at the IACVEI International Volcanological Congress in Cape Town, South Africa, 1998. White, McPhie and Skilling (2000) offered a definition of peperite in the Bulletin of Volcanology Forum (vol 62, pg 65-66). The special issue in JVGR includes three papers by CODES researchers and reflects the common occurrence of peperite in submarine volcanic successions (*these references are included later in this issue – Ed.*).

VOLCANIC HAZARD MANAGEMENT IN THE SOUTH WEST PACIFIC: THE WAY FORWARD

Paul W. Taylor
Australian Volcanological Investigations, Pymble, NSW, Australia.
Shane J. Cronin
Institute of Natural Resources, Massey University, Palmerston North, New Zealand.

Introduction

Many countries within the Southwest Pacific are part of or within the Pacific "Rim of Fire" and are constantly at risk from the effects of volcanic eruptions. Estimates suggest that more Pacific Island Country (PIC) people have been killed or are at risk from volcanic eruptions than any other geological hazard (Howorth and Elaise, SOPAC Miscellaneous Report 245, 1997). In the last 150 years a number of eruptions within the region have caused extensive losses to both life and property (**Table 1**).

As a direct consequence of the events outlined in **Table 1**, serious thought is required within the South West Pacific region for the effective management of volcanic hazards in the future because:

- the timing and nature of past volcanic events are unknown at most centres;
- the mechanisms and magnitudes of potential future volcanic eruptions are poorly understood;
- there is little or no monitoring support to predict the timing of renewed activity;
- some eruptions are long term events (months to years) and many will have regional implications, beyond the "volcanic" island nations (i.e. air and sea transport, economic), and;
- there is often permanent damage caused with resettlement

TABLE 1: Effects of Some Recent Volcanic Eruptions[1] in the South West Pacific

COUNTRY	VOLCANO	DATE	NUMBER OF DEATHS	REPORTED DAMAGE	MAIN PROCESS CAUSING DAMAGE/FATALITIES
Tonga	Niuafo'ou	1853	25[3]	Destruction of 'Ahau village	Lava flows
		1886	11[3]	Destruction of all villages on island	Ash fall (deaths caused by effects, eg. shock, breathing problems)
		1946	None reported	Partial destruction of Angaha village, island evacuated for 12 years	Lava flows
Samoa	Savai'i (Matavanu)	1905-11	None reported	Destruction of five villages, and large areas of agricultural lands	Lava flows, volcanic gases
Vanuatu	Ambrym	1894	10	Unknown	Lava flows, Ash fall
		1913	21	Several villages destroyed, hospital destroyed	Ash fall
	Aoba	1870[2]	Many[3]	Many villages destroyed	Lahars (volcanic mudflows)
Solomons Islands	Tinakula	1840[2]	Many[3]	All inhabitants of island killed	Pyroclastic flows (glowing clouds)
	Savo	1840[2]	Many[3]	Island totally devastated on several occasions	Pyroclastic flows
Papua New Guinea	Lamington	1951	2,942	North flanks almost totally devastated.	Pyroclastic flows
	Rabaul	1850	Many[3]	Extensive damage to the west and north of the active vents	Ash fall, ballistic ejecta
		1937	507	Almost total devastation around Vulcan Crater on west side of harbour	Pyroclastic flows, Ash fall
		1994	10 (at least 22 other casualties were reported)	Extensive areas to the west and north of the harbour were devastated	Ash fall, building collapse (as a result of heavy ash on roofs)
	Ritter Island	1888	3,000[3]	Island almost totally destroyed, extensive damage in coastal areas of surrounding islands	Tsunami (caused by collapse of part of the volcano)
	Karkar	1895	21[3]	Gardens destroyed	Ash falls, mud flows
		1979	2	South eastern part of summit region devastated	Directed blast (pyroclastic surge)

[1] Data for eruptions and their effects taken from Volcanoes of the World (ed T Simkin & L Siebert) Geoscience Press 1994; [2] Precise date of the eruption is not known, date estimated mainly from oral traditions; [3] Exact number of fatalities not known, fatalities estimated from known reports.

consequences – a thorny issue in many PIC cultures.

Regional Capacities for Effective Volcanic Hazard Management

Many of the countries within the region

have limited means and large amounts of overseas aid are required for development projects. Hence, many countries where there is a significant risk from active volcanism (except Papua New Guinea and to a lesser extent Vanuatu) have very limited volcano monitoring or volcanic hazard management systems. The countries of most concern include Tonga, Samoa, Fiji, Solomon Islands and Vanuatu. Where capacity building has been attempted, it has normally been in a piecemeal fashion, although mostly with the assistance of regional organisations such as SOPAC. To ensure that an effective volcanic hazard support program is established, the following capacities are required:

- Assessment of volcanic risk;
- Surveillance and monitoring;
- Event-triggered "operational support plans", plus other ongoing "risk management plans", and;
- Education and awareness programs that reach and involve communities at risk.

At a recent "Workshop on Volcanic Hazards and Emergency Management in the SW Pacific" (R. Howorth and A. Elaise, 1997), attended by scientists and disaster management officials, it was established that there was a significant risk from volcanic hazards in many of the countries. Specific volcanoes that were highlighted as those requiring urgent attention included:

- Niuafo'ou – Kingdom of Tonga;
- Taveuni – Fiji;
- Savai'i – Samoa;
- Savo – Solomon Islands;
- Gaua and Ambae – Vanuatu, and;
- Witori/Pago and Loloru – Papua New Guinea.

It was further emphasised by the workshop that:

- all of these were active volcanic systems, with a history of recent eruptions that have had significant impacts;
- all have a vulnerable population either living on the island or in close proximity, and;
- all are remote from potential assistance, particularly Niuafo'ou, Tonga's remotest island, which is situated 450 km NNW of Nuku'alofa and 130 km from its nearest neighbour.

The Way Ahead for the South West Pacific

A major aim for the future of PICs is to develop a within-region or within-country capacity to manage their volcanic risk. A step toward this could be a coordinated, sub-regional, volcanic risk management framework to foster cooperation between countries that are at risk from volcanic hazards and build on existing capacities. The mechanisms proposed include:

- Scientific and technical assistance for risk assessment, monitoring system development, risk management planning and operational support planning;
- Training and exchange programs, and;
- Utilisation of within-region expertise, e.g. Papua New Guinea, Vanuatu and Fiji.

With the development of regional support agreements, countries within the region will be able to assist one another during times of need.

Goals

The major goals of the program are aimed at both regional and in-country capacity building and raising the awareness and preparedness levels of the community. Major goals are to:

- Increase community resilience to volcanic risk;
- Build sustainable capacities to independently prepare for and manage volcanic disasters;
- Develop a sub-regional mutual

assistance framework;
- Provide targeted scientific and technical assistance to priority areas, and;
- Prepare all countries for effective utilisation of monitoring systems.

Methodology
The methodology during the program should fully involve local scientific staff and disaster management officials and will build their capacities and increase awareness. It should include:

- A needs appraisal (covering all aspects of hazard and risk knowledge state and disaster planning capacity);
- Targeted hazard and risk assessments for identified and agreed-upon priority areas;
- Training in volcanic hazard assessment and monitoring techniques for local geologic staff;
- Operational Support Plan development in targeted areas;
- Training in volcanic disaster management for disaster management officials and other relevant staff;
- Development of holistic and ongoing risk-management plans, and;
- Staff exchanges, joint training and subregional workshops.

Expected Outputs
The outputs of the program should ensure that an effective, coordinated regional volcanic hazards management program is developed, that enables countries with expertise to provide assistance to their neighbours when and where necessary. Specific outcomes include:

- A data base of volcanic hazard and disaster management information and expertise available within the region;
- Needs appraisal reports for each country;
- Hazard assessment reports for the highest priority volcanic sites within the region;
- Trained regional geology staff and training materials and manuals;
- Guideline report outlining the requirements for volcanic hazard maps;
- Operational Support Plans for the highest priority sites;
- Trained disaster management staff with training materials and manuals;
- Revision of existing Operational Support Plans and the development of a guideline report on the requirements for an Operational Support Plan;
- Development and strengthening of awareness programs and the preparation of materials;
- Preparation and implementation of ongoing risk management plans and strategies, and;
- Memoranda of Understanding or other agreements between nations to allow the ongoing exchange of information and expertise supplemented by external assistance when required.

Progress So Far
Although no formal agreements have been established, a group of scientists from Australian Volcanological Investigations, Massey University and the British Geological Survey, coordinated by SOPAC have commenced a systematic program to assess the risk of future activity and its implications on the highest priority volcanoes. The process that has been used by this group along with their in-country counterparts has included:

- reviews of existing volcanological data;
- conduct of a detailed geological survey (if required);
- conduct of a hazard/risk assessment;
- preparation of a volcanic hazard map;
- development of Operational Support Plans, and;
- development of national/island

TABLE 2: The status of volcanic hazard management in selected countries of the SW Pacific

Volcano	What has been Done	What is Still to be Done
Niuafo'ou	• Geology and volcanic history - 1983-90 • Volcanic hazard assessment - 1992-94 • Operational Support Plan - 1996-98 • National workshop - late-May 1999 • Island workshop - early-June 1999	• Adoption of Operational Support Plan by Tongan Government • Establishment of the Niuafo'ou Preparedness & Emergency Committee • On island test of the Plan • Establishment of a monitoring program • Development of national/island education and awareness programs
Taveuni	• Geology and volcanic history - 1997-98 • Volcanic hazards assessment - 1998-99 • Operational Support Plan - 1999 • National planning workshop - June 1999 • Island workshop - Dec 1999	• Adoption of Operational Support Plan by Fiji Government • Development of national/island education and awareness programs
Savai'i	• General geology - 1940s-50s • Volcanic hazards assessment - 1998 • National workshop - Sept 1999	• Detailed re-evaluation of volcanic history – planned October 2000 • Establishment of a monitoring program • Development of Operational Support Plan • Development of national/island education and awareness programs • Island workshop

education and awareness materials and program outlines.

It is further emphasised that the above process is an integrated process involving scientists, disaster management officials, planners, emergency services, education services, and a whole host of others from all levels and sectors within the community. **Table 2** provides a summary of what has been completed and what is still to be done for the volcanoes highlighted earlier.

CHARACTERISTICS AND ORIGIN OF PEPERITE INVOLVING A COARSE VOLCANIC HOST

Rick J. Squire & **Jocelyn McPhie**
LAVA members, CODES SRC

(From a paper by Squire and McPhie, submitted to *Journal of Volcanology and Geothermal Research*).

The active volcanic settings in which peperite is formed are typically depocentres for diverse sedimentary facies that can include large volumes of coarse volcanic breccia and volcanic conglomerate. However, most peperite described in the literature involves relatively fine-grained sediment. There are few descriptions involving coarse-grained host sediment (Busby-Spera & White 1987, Hanson & Wilson, 1991), perhaps because of difficulties in identification rather than low abundance. The difficulties arise because clasts derived from the magma may be similar in texture, size and shape to igneous clasts in a volcaniclastic host. This is especially true in cases involving blocky peperite and volcanic breccia. Host sediment properties (grain size, porosity, permeability) may influence intrusion and fragmentation processes during peperite formation (e.g. Busby-Spera & White 1987, Kokelaar 1982, 1986). Cases involving coarse host sediment can thus be expected to illustrate relationships not evident in the more commonly described cases involving fine-grained sediment. Therefore, detailed description and interpretation of peperite involving coarse host sediment are important in achieving a better understanding of peperite formation, and in developing criteria for peperite identification.

Peperite involving basalt and polymictic volcanic conglomerate occurs in the Pliocene Ba Volcanic Group at Yaqara in northern Viti Levu, Fiji. Because the host sediment is coarse grained and dominated by basalt clasts, the peperite could be easily overlooked and mistaken for another coarse volcaniclastic facies. However, the presence of groups of basalt clasts that show jigsaw-fit texture, fluidally-shaped basalt clasts with complete glassy margins, gradational contacts with adjacent sedimentary facies and the absence of stratification indicate that molten basalt mingled with unconsolidated gravel. Using these criteria, peperite may be distinguished from other superficially similar, coarse, polymictic facies with fluidal basalt clasts.

Both blocky and fluidal basalt clasts occur together in the peperite of the Ba Volcanic Group. The amoeboid basalt clasts in the fluidal peperite result from dismembering of ductile, low viscosity, relatively hot magma. At this stage, propagating magma lobes were probably insulated from direct contact with the wet sediment by a vapour film. The angular, polyhedral basalt clasts in the blocky peperite indicate brittle disintegration of somewhat cooler, higher viscosity magma. The presence of jigsaw-fit texture and polyhedral clasts with glassy margins suggest that quench fragmen-tation of the basalt was important in formation of the blocky peperite. Although there is no positive evidence for steam explosivity, the presence of steam could be recorded by small quartz-filled cavities that occur within the host sediment. The co-existence of fluidal and blocky basalt clasts is interpreted to reflect successive ductile then brittle fragmentation of intruding magma. The change from fluidal to blocky peperite might have resulted from progressive cooling of the magma during intrusion, and also from the breakdown of fluidisation when the limited supply of fine sediment in the host gravel was exhausted.

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PUMICE AHOY!

Lin Sutherland
LAVA Member, Australian Museum,
Sydney NSW.

Pumice is a well known floating rock. Sometimes it can travel on oceans, assisted by the wind and currents, for thousands of kilometres from its birth place. The rock is gas-riddled lava with a frothy appearance and is usually silicic in composition. Experiments show that cooler pumice when meeting water can remain afloat over a year or more. Pumice hotter than 700ºC does not readily float and sinks rapidly.

Some spectacular strandings of pumice coat Australian shores at times, especially when washed ashore during heavy storms. The pumice can come from many points of the compass. It is particularly prone to wash up about a year after eruptions in the Kermadec-Tonga and Vanuatu volcanic arcs in the South West Pacific, a travel distance of up to 3000-4000 km. Pumice can arrive from even more distant sources. A good example is pumice from the 1962 South Sandwich Islands eruption, which reached southern Australian shores 8000 km away in late 1963. Other identified starting points for Australian strandings include volcanic sources in Indonesia, New Zealand and the Indian Ocean. Pumice that first washed up on Heard Island, Southern Ocean, in 1992 is now thought to derive from eruptions on nearby McDonald Island.

Palaeopumice beds are found within littoral deposits at many Australian coastal sites and have been dated back to 6000 years before present. Studies of these pumices suggest volcanoes from South West Pacific sources have regularly delivered pumice into the East Australian current system for eventual stranding along Coral Sea and Tasman Sea landfalls. Pumice pieces can later recycle into younger deposits through wave and storm erosion or even from tsunami events. Pumice from Tongan and particularly Metis Shoal area eruptions were identified in Aboriginal midden deposits dating back 1,800 to 3,500 years at Balmoral Beach, Sydney Harbour. Characterisation of pumice in palaeostrandings has assisted stratigraphic correlations of coastal dune and beach systems along Queensland and New South Wales coasts. In one case, pumice found with an ancient lead weight on Fraser Island, Queensland, helped narrow the age of this artefact to within the period 1,410 to 1,630 AD.

Besides its purely volcanic interest, pumice plays a role in the story of ocean current patterns and restocking of marine habitats through adhering exotic marine life. It is a splendid educational aid for many topics, as teachers can use it to illustrate volcanism, oceanic circulation, coastal wave sorting, biological transport, ancient history (e.g. Pompeii buried in pumice) and human uses of rock materials.

The Australian Museum has a range of pumice samples collected by its scientists or by interested public from various strandings along the eastern coast and offshore islands. It is hoped to investigate the volcanic sources of these documented samples, using detailed geochemistry and to set up a ‘coast watch’ program for collecting new pumice arrivals. Anyone wishing to contribute to the project should contact **Dr. F.L. Sutherland, Earth and Environmental Sciences, Australian Museum, 6 College Street, Sydney, NSW 2010** (Phone 02 9320 6100; Fax 02 9320 6050, e-mail: lins@austmus.gov.au).

Selected Pumice Literature

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ENVIRONMENTAL GEOTOURISM OF VOLCANOES TOWARD REVITALIZING THE NATIONAL ECONOMY OF INDONESIA

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From time immemorial, volcanoes have sometimes invoked terror and religious veneration, and sometimes artistic appreciation of beauty and respect, in man. Before the 1980s, most people probably regarded volcanoes as phenomena of no relevance to their own normal lives. However, increased scrutiny of possible volcanic hazards has drawn attention to a number of catastrophic impacts, especially after the first few signs of the reawakening of an old volcano. Soon, the feeling of fatalism, resulting from the ill-facing of the destructive consequences, would arise when we convince ourselves that the "volcano would have its way!" For years, we used to hear and read about many new technologies and further knowledge employed toward avoiding worse future disasters (by creating new adequate alerting systems and planning conductive behaviour with post-consequent results). Usually, you hear many experts repeating the same saying: "we must do still more!" as though they consider the volcano as a fugitive wanted for justice dead or alive!

Today, many believe that volcanoes could act as good friends and benefactors if we go beyond terror and challenge, and learn how to make direct use of the volcano and its energy to serve the human well being and his luxury. Being well aware of this truth, however, many institutions have come to the realization that volcanoes have done in the past, and still do, more good than harm. I've been to Indonesia once and had the chance to visit Gunung Tangkuban Perahu volcano in Bandung, central Java. I've noticed closely how Indonesia can properly use volcanoes as a concrete pile for the sake of national development, particularly, the socio-economic part.

Tourism, like most industrial phases, participates strongly in increasing any nation's revenue; it facilitates an easy entry of much foreign currency into the country. Unfortunately, Indonesian currency nowadays is facing extreme foreign exchange difficulties (rate instability and oscillations) due to the existence of the present economic crisis throughout the whole region of Southeast Asia. Indeed, tourism will activate foreign exchange to the credit of Indonesia's outstanding account, which, in turn, will reflect positively on raising the Gross National Product (GNP) to more satisfactory levels. Considering volcanoes as a potential resource of the country's natural wealth, they would be a new way for investors to send for needed foreign currency in the country under the guise of tourism. A "Volcanic tourism project" is suggested to have many distinguishable characters making this kind of investment economic and beneficial. To highlight some:

1. it is closely related to specific locations that actually serve the strategic targets of tourism. These locations are the best ones to give joy and inspiration to thousands of vacationers; volcanoes may be the only places on the earth possessing a number of fascinating unique sites suitable for medical (i.e. geysers & hot springs) and health resorts among other natural geographic features;

2. investment capital needed is relatively low compared with other tourism projects because few special, high technology supplies and services are required to agree with tourist attraction competency;

3. the running costs of project operation are comparatively low as varied raw materials are naturally available. Indonesian volcanoes can give the investors endless charming artistic constructions of the "nature-made" mark;

4. it requires cheap and low-cost employment capacity at the outset. Labor would be directly selected from a near-by community (i.e. native villagers). Many Indonesian agrarians are involved professionally in gem-mological handicrafts. This, in turn, has many constructive effects on the record of socio-economic conditions;

5. it has no direct negative impacts on the surrounding environment (eco-system equilibria) which implies that this kind of investment acts as a friendly-environment based project.

In conclusion, it is clear that going into business with volcanoes is of crucial importance in contributing to the active increase of foreign currency fortune and therefore revitalizing the national economy from downturn. In addition, offering the natives a number of job opportunities has a vital assistant effect to help the Indonesian government in struggling with the widespread burden of unemployment. Bearing in mind, that sufficient investment in volcanoes will surely save the government many foreign dollars by bringing civilization and development plans to many very remote areas, even to many selective locations still unoccupied by humans. Not to mention, there's no community nowadays that would refuse aggressively what so-called "urbanized culture" would bring their own original one. Personally, if Indonesia succeed in managing the inputs/outputs of this kind of investment, along with suitable advertising, and let volcanoes "overtake other kinds of investments", it would be the biggest promoter, if not the monopolist, in the international business markets of tourism. Again, we come out with a new, but old, idea: "we must learn how to live with volcanoes".

ACTIVE VOLCANO MONITORING: SYSTEM UPDATES IN PAPUA NEW GUINEA AND THE PHILIPPINES

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The Australian Geological Survey Organisation (AGSO) and it predecessor BMR has a long history of involvement with volcano monitoring, mostly resulting from projects connected with community geohazard-related issues in Papua New Guinea since the 1930's, but also related more recently to aircraft safety along the air corridors into and out of Australia.

In the last five years AGSO has played a major role in two large projects that have had a major bearing on how active volcanoes are monitored in the western Pacific: 1) the Papua New Guinea Volcanological Services Support Project funded by the Australian Government (AusAID), and 2) the Project for Improvement of Earthquake and Volcano Monitoring in the Republic of the Philippines funded by the Japanese Government (JICA). Both projects were triggered by major eruptions, the 1991 eruption of Mount Pinatubo and the 1994 eruption of Rabaul volcano. Both had a significant effect on the social fabric and economy of the countries involved.

The Australian and Japanese aid agencies sought ways and means of reducing the social and economic impact of eruptions in the future. The strategy for achieving their aims included improv-ements to real-time volcano monitoring systems so that increases in volcanic activity could trigger alerts for an emergency management response from government authorities if necessary.

The Papua New Guinea Volcanological Services Support (VSS) Project

The 1994 eruption of Rabaul volcano devastated the town of Rabaul and there was a huge downturn in the economy of the region. After the initial emergency was over, Australia and other countries developed reconstruction strategies for the region including dispersal of key facilities to less vulnerable locations on the Gazelle Peninsula and the upgrading of real-time volcano monitoring systems in PNG. The VSS project aimed to introduce improved monitoring systems for Rabaul volcano and also at four other 'high risk' active volcanoes in PNG, Ulawun, Lamington, Karkar and Manum. AGSO implemented the new systems in the period 1995-1999 with the key monitoring centre being at the Rabaul Volcanological Observatory (RVO).

The seismic monitoring network at Rabaul now comprises fifteen stations with digital data telemetered to an RVO database, and an automatic earthquake location system based on the USGS Cascades Observatory 'PORKY' system. In addition there are three real-time GPS ground deformation monitors and four tide gauge stations. To locate volcano-related earthquakes more precisely, an improved seismic velocity model was required for the caldera. This was achieved by conducting a seismic tomography investigation during 1997-98 with station spacings of 1-5 km to image the deep structure of the volcano (Gudmundsson et al, 1999), the Rabaul Earthquake Location and Caldera Structure (RELACS) project. This project was conducted in cooperation with the Research School of Earth Sciences at Australian National University, University of Hokkaido, and University of Wisconsin. **Figure 1** shows a cross-section through the caldera illustrating the variation in P-wave velocity and highlights the presence of a zone of significant P-wave velocity reduction at 3-7 km depth interpreted to be a zone of fractured rock containing magma.

Monitoring of the other four 'high risk' volcanoes (Ulawun, Lamington, Karkar, Manum) on a real-time basis has been achieved using HF radio links between the volcanoes and RVO. Monitoring sites at each volcano are located high up on the flanks of the volcano. Each site has three-component seismometer, digital data logger, a digital tilt meter, and a UHF radio transmitter. Data are transmitted via the UHF link to a base station, usually at a local village or plantation a few kilometres away. Ten-minute average values of seismic tremor, tilt and event triggers are logged at the base station and transmitted to RVO via

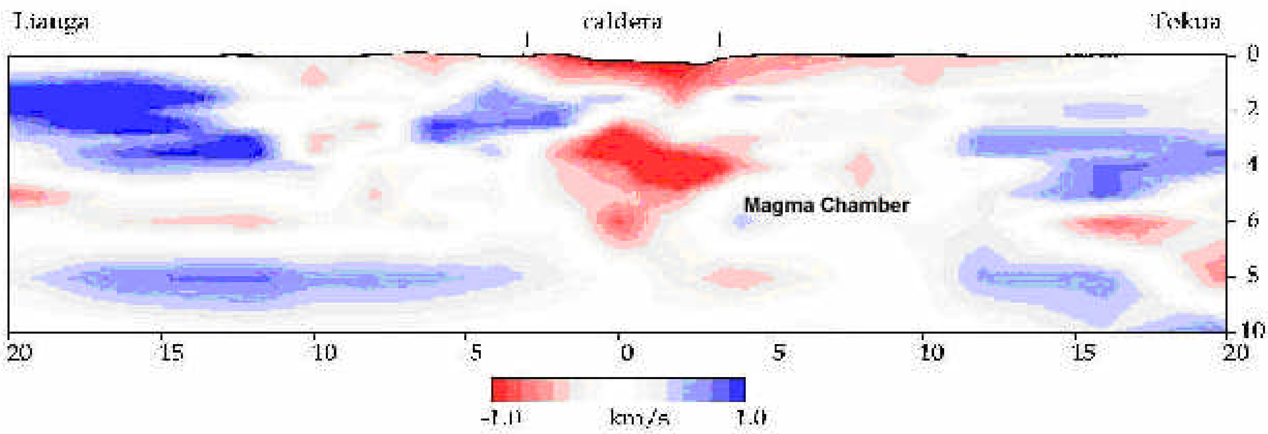

Figure 1: P-wave velocity variations across the Rabaul caldera interpreted from seismic tomography data acquired during the 1997-98 RELACS investigation. The patch in the centre of the cross-section indicates the region of reduced velocity indicative of hot magma intrusion.

the HF radio link every twenty minutes. The HF links are up to 800 km long and the radio frequencies are switched according to the time of day.

The RVO real time monitoring system was tested in the second half of 2000 when Ulawun showed signs of activity. The whole active episode was monitored and at one stage the civil authorities and local population was placed on alert for evacuation. Volcanic activity at Ulawun has since subsided but for RVO it was a good indicator of their system credibility. It is possible that the HF radio monitoring system based at RVO may be extended to other active volcanos in PNG in the next few years.

For the earth scientist, life at Rabaul is never dull. Located at the triple junction between the Solomon, Bismarck and Pacific plates, tectonic activity is an every-day occurrence. The Tavurvur volcanic vent continues low level eruption activity, spreading ash and dust over Rabaul town and making life miserable for the inhabitants. In addition, on 16 December 2000 an Ms 8.0 earthquake shook the town followed by several magnitude 7+ events. A small tsunami was experience along some coastlines near Rabaul and caused minor damage. Surveyors from various groups including the Research School of Earth Sciences, ANU, have been monitoring crustal deformation across the region and early reports indicate base station movements of up to 1 m. Volcano monitoring is but one essential element of government business aimed at reducing the social and financial risks from geohazards in the region.

The Project for Improvement of Earthquake and Volcano Monitoring in the Republic of the Philippines

The 1991 eruption of Mount Pinatubo about 90 km northwest of Metro Manila and the major central Luzon earthquake the previous year triggered a program by the Japanese Government to assist the Philippines Government with upgrading its

Figure 2: Digital seismic monitoring system at Mayon Volcano Observatory, southern Luzon Island, Republic of the Philippines.

volcano and earthquake monitoring network (**Figure 2**). This program lead to the installation of modern digital recording systems at thirty four sites throughout the Philippines during year 2000, including the active volcano monitoring observatories at Pinatubo, Mayon, Bulusan, Hibok Hibok and Kanloan. Volcanic activity is a major community and government issue that requires ongoing advice about likely levels of risk. This advice is provided through the Philippine Institute of Volcanology and Seismology (PHIVOLCS). Like many other countries, the fertile land around volcanoes is farmed intensively and if communities have to be evacuated, the cost to government is significant. In January 2000 Mayon volcano erupted, closing down airports and industry in the neighbouring city of Legazpi and the government had to house and feed 25,000 evacuees for about two months.

The newly installed digital seismic monitoring systems in the Philippines were designed, built and installed at a total of thirty four stations by a consortium of Australian agencies in cooperation with Mitsubishi Corporation of Tokyo. The agencies were the Australian Bureau of Meteorology, the Australian Geological Survey Organisation and the Seismology Research Centre (SRC), Mindata Pty. Ltd. The monitoring systems were built round SRC Kelunji-D seismic data loggers, SRC KD2 drum recorders, Geotech S13-J seismometers (3-component) and PA22 accelerometers (3-component). Data analysis facilities were established at each site using IBM PCs with modem transfer of data to PHIVOLCS Head Office in Quezon City (Metro Manila) by automatic dial-up phone line.

Although designed to monitor regional earthquakes, the observatories at active volcanoes also record volcano-related events. It is expected that future expansion of the recording systems will include seismic array monitoring of active volcanoes using a telemetry system similar to that used at Rabaul. Currently PHIVOLCS can issue a bulletin on damaging regional earthquakes in less than ten minutes.

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VOLCANIC VENTS AT 'EL CAPITAN', COBAR NSW

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AT LONG LAST, after more than a century since its joint discovery by Mr. W. Anderson and Mr. J. M. Curran in 1887, a number of eruption localities for the 'El Capitan' area leucitites have been found.

El Capitan is located approximately 64 km south of Byrock Mountain and 56 km NE of Cobar, in the County of Canbelego, New South Wales. The outcrop consists of numerous small highly detached hills of leucitite lava that erupted onto the Cobar landscape at approximately 15.7 ± 0.2 Ma (Sutherland 1983, 1985). The leucitites erupted as a result of migratory volcanism, perhaps reflecting the movement of the Australian lithospheric plate northward over magma sources in direct response to seafloor spreading between Australia and Antartica (Wellman & McDougall 1974). Further discoveries at Lake Cargelligo, Bygalorie, Griffith, and at Cosgrove in Victoria, demonstrate a linear leucitite trend. This string of occurrences, comprising the western-most Cainozoic lava flows in New South Wales, was subsequently named the "Condobolin Province".

The close proximity between the Byrock and El Capitan leucitites suggests a related origin for the exposures. This view, however, is dismissed as no evidence of leucitite basalt was found in the country between them. Gilligan and Byrnes (1994) propose that the "plan shape of the El Capitan flow remnant, and the nature of the underlying sediments, are suggestive of a former river or stream" draining in a S-SE direction. This view, however, contradicts the present drainage and general landsurface draining towards the Darling River in the N-NW.

The discovery of two vents to the south of the main exposures, namely the Wilga Tank vent and the Sunrise Tank vent in the Yimkin area, are major breakthroughs toward understanding the landscape evolution of the area.

The Wilga Tank vent is located approximately 8 km southwest of Mountain Tank (the largest outcrop) and consists of approximately 300 square metres of radially-jointed leucite-bearing basalt with abundant small mantle xenoliths, lava benches and scoria. This vent has an associated perched lava flow underlain by a pre-basaltic weathering profile and pre-basaltic stream sediments. The perched lava flow has been topographically inverted and stands approximately 17 m above the surrounding undulating plain. This implies erosion rates of approximately 1 m/Ma.

The Sunrise Tank vent lies approximately 10 km to the southeast of Mountain Tank and consists of approximately one square kilometre of leucitite with very subdued exposure. This has an extensive regolith cover (alluvial and colluvial) around the margins, possibly as a result of being in close proximity to the Tooram Hills (Devonian conglomerate and sandstone with minor siltstone). Thus, the "true" size of the exposure cannot be determined, although outcrop was seen in surrounding creeks a few metres from the main outcrop and ground magnetic "edge-effects" may be used to more accurately determine its' extent. This exposure also displays radial jointing and mantle xenoliths. No scoria was found at this locality.

Aeromagnetic surveys have shown that both exposures have a very strong magnetic response, a negative anomaly, commonly associated with reversed polarity at time of eruption. The magnetic response also shows large maghemite-filled palaeochannels and/or present channels connecting the exposures at El Capitan and Mountain Tank, lying to the north, with the Sunrise Tank vent. This suggests that this larger volcanic plug may have provided the lava for the northern leucitite exposures, while the Wilga Tank vent is considered to be a "satellite vent." with no subaerial connection to the main lava flow system. Aeromagnetic surveys have shown large basement faults cross-cutting the area and show the Sunrise Tank vent coinciding with the regional Eagle Lineament-the northern continuation of the famous Gilmore Suture-which transects the eastern margin of the mapping area in a north-south direction.

Rittmann (1963) calculated an explosivity index (E) of less than 1% for all volcanoes with leucititic affinities, suggesting that these eruptions were predominantly effusive and related to small vents which may have covered-over and sealed after one major period of eruption. This has been suggested by Assoc. Prof. Ken McQueen, particularly for the large "El Capitan" and Mountain Tank exposures (**Figure 1**), although the lack of a large magnetic anomaly at the outcrops prompts Dr. Ian Roach to disagree.

Erosion has played a major role in the shaping of the present-day El Capitan landscape. The exposures have been interpreted as remnants of (a) lava flow(s) which have been topographically inverted after initially flowing down an old drainage channel. Subsequent removal and erosion of pre-basaltic sediments by twin lateral streams is believed to imply erosion rates as high as 3 m/Ma (i.e. basalt top to valley

Figure 1: The Mountain Tank leucitite exposure at El Capitan. Note the elevated portion on the right and the dip of the exposure to the left. This suggests the presence of a buried vent at this locality.

floor distance exceeds 35 m). The recent discovery at Yimkin suggests that erosion rates have not exceeded 1 m/Ma and thus the process of flow inflation and slow emplacement is an attractive mechanism for emplace-ment of the 'El Capitan' area leucitites. However, absolute inflation height can not be determined although megavesicles and pahoehoe flow structures suggest that the current flow surface is within some few metres of the former flow tops.

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*Eds note: Osvaldo (Lalo) is an Honours student in the Cooperative Research Centre for Landscape Evolution and Mineral Exploration at the University of Canberra and is co-supervised by Assoc. Prof. Ken McQueen and, Dr Ian Roach (LAVA Committee).

CHARACTER AND ORIGIN OF WIDESPREAD FELSIC UNITS IN THE GAWLER RANGE VOLCANICS

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The Gawler Range Volcanics (GRV) is one of the largest known and best preserved ancient intraplate felsic provinces in the world. It includes several widespread felsic units that are the focus of current research undertaken at the University of Tasmania. The project was initiated in 1996 and is supported by an ARC Large Grant in collaboration with PIRSA Mineral Resources.

The eruption style and emplacement mechanisms for voluminous and extensive felsic units such as those in the GRV are problematic. They are widespread yet have textural features that most resemble lavas and lack pyroclastic textures generally associated with ignimbrites (e.g. Henry and Wolff 1992). Several documented examples have been interpreted to be densely welded ignimbrites by some or lavas by others (e.g. from Idaho, USA: Ekren *et al*. 1984, Bonnichsen & Kauffman 1987, Manley 1995).

The Eucarro Dacite and Yardea Dacite are extensive (>200 km long), felsic (65-75% SiO_2), phenocryst-rich (15-40 vol. %) units that cover much of the central and southern parts of the GRV. They are generally evenly porphyritic and contain mainly unbroken, euhedral phenocrysts. Fractured phenocrysts and uneven phenocryst abundances are restricted to zones that are flow banded or mingled and can be attributed to shear stress during flowage. Flow banding is present at the base of both units. In addition, centimetre-scale flow banding is particularly well developed where different textural and compositional domains have mingled. The flow banding is often steeply dipping.

In addition to the evenly porphyritic textures, the Eucarro Dacite and Yardea Dacite display several other features that suggest they were emplaced as lavas. Both units include felsic clasts and megablocks (up to 50 m in diameter) that have been derived from the basement and from early-crystallised plutons. They are commonly round, randomly positioned within the host unit, non-graded and show textures indicative of partial melting. They are interpreted to have been periodically dislodged from the magma chamber walls and were near neutrally buoyant when entrained by the rising magma. Furthermore, the source, size, and random nature of these clasts suggest that they were erupted passively and remained suspended in lava during outflow (Garner and McPhie 1999). In addition, intricate mingling is present between the Eucarro Dacite and Paney Rhyolite which suggests mingling commenced during simultaneous withdrawal of these two magmas and continued during a fundamentally effusive or very weakly explosive (fountaining) eruption (Morrow & McPhie 2000).

The Eucarro and Yardea magmas had relatively high pre-eruption magma temperatures (900-1100°C: Creaser & White 1991, Stewart 1994), and were comparatively dry (2 wt% H_2O; Creaser & White 1991). Effective magma viscosities ($<10^6$-10^7 Pa s: Stewart 1994) were lower than those of conventional felsic magmas, allowing greater discharge rates and wide outflow as lavas. The interior of such lavas can remain hot and ductile as the upper and lower crusts provide very effective insulators restricting heat loss (Manley 1992) and permitting extensive outflow. The large volumes of these units and their internal variations also indicate that the eruptions tapped voluminous but compositionally heterogeneous, hot magma.

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THE JERRABATTGULLA CREEK BASALTS AND THE SHOALHAVEN FAULT: SOURCE-PROXIMAL LAVA PILE OR NEOTECTONIC THICKENING?

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The Jerrabattgulla Creek basalt is a small lava field situated in the headwaters of the Shoalhaven River catchment of SE NSW. The lava field lies in close proximity to the Shoalhaven Fault and the Great Divide and is the only reported basalt in the high-relief headwaters of the river. Numerous lava flow remnants exist in the lower and middle parts of the catchment. These have been the focus of many landscape evolution studies because they appear to preserve the pre-basaltic relief of the river. These studies include the long-term rates of river incision, headward gorge retreat and scarp retreat (e.g. Nott *et al.* 1996, Young 1977, Young & McDougall 1985).

Rock types & outcrop pattern

Wyborn & Owen (1986) originally mapped the lava field, noting that it consisted of nepheline-bearing alkaline basalts, and obtained a K-Ar age of 19.1 ± 0.4 Ma for one of the upper-most flows. A more recent study by Lewis (2000), using new geochemistry of each lava flow, has shown that the lava field composition is actually much more diverse than previously noted. Basalts within the Jerrabattgulla Creek outcrops are now known to include a variety of primary to weakly-evolved nepheline- and hypersthene–normative rocks including ol-nephelinite, ne-basanite, ne-tephrite, ne-hawaiite, hy-hawaiite, hy-trachybasalt, transitional basalt and quartz tholeiite. The range of rock types within this restricted area provide a unique view of the geochemical evolution of eastern Australian lava fields; what would normally be considered "monogenetic" is actually polygenetic! Preliminary major and trace element modelling shows that both asthenospheric and sub-continental lithospheric mantle sources were involved in the magma-genesis of these rocks.

The lava flows extend ca. 5.5 km northward, down the Jerrabattgulla Creek valley. The area has been extensively dissected by the lateral Jerrabattgulla Creek since volcanism, leaving five remnant piles of varying size distributed evenly over this distance. Each of the piles display terraced topography, the terraces representing individual lava flows. The average flow thickness is approximately 10 m, with the lava pile remnants reaching a maximum thickness of eight flows and a minimum thickness of one flow. The remaining flows are situated at high elevations in the landscape due to relief inversion caused by substantial weathering and erosion since the Miocene.

Basalts and neotectonics

Wyborn & Owen (1986) mapped the Jerrabattgulla Creek basalt as being displaced by the Shoalhaven Fault. Tectonic thickening seems reasonable when considering that the thickest part of the lava pile has relatively high elevation (1090 m ASL), high relief (ca. 100 m) and lies closest to the fault scarp. Other possible explanations for the difference in pile thicknesses either side of the fault include: that lava once filled the whole valley to an elevation of 1090 m; or that lava flowed over the scarp from a vent situated somewhere in the vicinity of the Great Divide.

The faulting theory has two major flaws: the calculated displacement of 65 m (Lewis 2000) contradicts Wyborn & Owen's (1986) previous estimate of 30 m; and the geochemical evidence suggests that the individual flows are correlated parallel to the Shoalhaven Fault, but not across it. It would be expected that if there were vertical movement, rock types would be repeated across the fault but there is no geochemical evidence to support this. If movement has occurred it would have to be minimal, less than the thickness of one lava flow (10 m).

It seems unlikely that this was a large valley-filling lava flow, because only a few remnants occur on the western valley wall. Furthermore, assuming that the lava filled the valley to the maximum elevation of its field settings (1090 m), the amount of material removed since the Miocene is of such high volume that this amount of erosion can not be supported by present field evidence and knowledge of denudation rates. In addition, it seems unlikely that the lava has flowed over the scarp because the individual flows have sub-horizontal attitudes.

Given that neither the valley filling nor the faulting scenarios are reasonable explanations, the last possibility is that the vent was situated in the vicinity of the thickest part of the lava pile. This location coincides with the junction of the large N-striking Shoalhaven and NW-striking Mulwaree Faults, suggesting that eruption occurred at this point. Roach *et al*. (1994) and Roach (1999) demonstrated that eruptions sites are associated with the intersections of similar faults in southeastern Australia. In addition to this, the elevations of the remnant lava outcrops decrease uniformly to the north, suggesting that the lava pile is thickest near the proposed vent site.

Conclusion

Recent mapping of the Cainozoic basalt in the Jerrabattgulla Creek valley does not support previous interpretations neotectonic displacement of 30 m on this segment of the Shoalhaven Fault. Evidence suggests that the volcanism at this location was of Hawaiian to Strombolian character and the eruption site was located over the junction of the Shoalhaven and Mulwaree Faults.

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AN INSIGHT INTO A JURASSIC DOLERITE SILL, MT GERYON, TASMANIA

Miriam Fokker*
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Voluminous dolerite sills characterise much of the geology of Tasmania. During the Jurassic period, at a time of instability for the supercontinent Gondwana, dolerite was emplaced into the Triassic *Parmeener Supergroup* (Banks 1973). Ice movement during Pleistocene glaciation remodeled the landscape of Tasmania, exposing the dolerite sheets we see today. The Mt Geryon Sill, located in central western Tasmania, is part of the extensive Tasmanian dolerite sheets that cover most of the State. The 400 m thick sill lies upon the Parmeener Supergroup and is considered to represent a cross-section of a complete dolerite sill. At first sight, the Tasmanian dolerite sills appear monotonously (at least in terms of petrography) uniform. The contact between the underlying Triassic sandstone and overlying Jurassic dolerite is sharply defined. The host sediment does not appear strongly hornfelsed by the intrusion of dolerite and xenoliths of country rock were not found in the dolerite. Detailed study of the Mt Geryon Sill, however, reveals a marked (albeit cryptic) geochemical variability and mineralogical heterogeneity that are most likely the result of magma differentiation *in situ*. Mechanisms of differentiation are crystal fractionation and crystal movement through crystal settling and convection.

Chemical Variation and Mechanisms of Differentiation of the Mt Geryon Sill

Petrographic investigations indicate plagioclase and pyroxene as the predominant minerals of the Mt Geryon Sill. It is clear through these investigations that the Tasmanian dolerite magma was saturated with pyroxene and plagioclase at the time of the intrusion. Rapid crystallisation of the chilled margin was followed by slow cooling inward, as detected by the changes in texture and coarsening grainsizes. The distribution and the changing composition of ortho- and clinopyroxene and plagioclase and textural differentiation clearly indicate the likelihood of fractional crystallisation and crystal settling taking place within the sill after emplacement of almost completely liquid magma.

Geochemical observations confirm the mineralogical variation from the chilled margin at the base to the top of the 400 m thick sill. Data display movement of elements with minerals within the Mt Geryon Sill, and thus indicate the involvement of such processes as crystal fractionation. Markedly consistent sigmoidal variation in major and trace element abundances as a function of height are present within the sill. Oxides and trace elements that are compatible to pyroxene reach peak concentrations at a height of 100-140 m. Conversely, major and trace elements that are relatively incompatible to pyroxene are depleted at this level and reach maximum concentrations at ca. 300-340 m height.

The bulk rock geochemistry reveals further evidence of fractional crystall-isation with the relative motion of crystals and melt as a contributing factor. The behaviour of minerals during crystall-isation can be deduced from the partitioning of major and trace elements. The accumulation/removal of elements signifies the major crystalline phase controls within the sill. Ca-rich pyroxene and plagioclase appear to control the crystal fractionation process. Major and trace element trends also suggest the displacement of minerals whereby pyroxene tends to sink, while plagioclase is relatively buoyant or floats as melt rises, thus suggesting variable amounts of crystal settling as a contributing factor to the process of differentiation.

Comparisons of trace element data to some previous studies of other Tasmanian dolerites (e.g. Hergt 1987, Hergt *et al.* 1989) illustrate similarities in chemical trends within the sill. However, data from chilled margin samples from previous studies have geochemical characteristics that are consistent with contamination (in part) by host arkosic sediments rather than contamination derived from an asthenospheric magma source (e.g. Hergt *et al.* 1991, Turner & Hawkesworth 1995).

Origin of the Magma Source

Pyroxene geothermometry applied to the Mt Geryon Sill samples confirms a crystallisation temperature of 1200°C-850°C. Ilmenite-magnetite thermobaro-metry gives a re-equilibrated subsolidus temperature of 850°C-600°C and oxygen fugacities at or below the fayalite -magnetite-quartz buffer curve. This suggests a MORB and/or OIB magma source rather than an oxidised island arc-type source. Several possible magma sources for the Tasmanian dolerites have been advanced, such as: melting of the sub-continental lithosphere with contam-ination from the continental crust (Campbell & Griffiths 1990); plume mantle model with little involvement of the lithosphere mantle or crust (Hawkesworth *et al*. 1988); and a plume derived from the asthenosphere (Arndt & Christenson 1992). It is not possible at this stage to determine which of these options is the most likely source. It is hoped, however, that further trace element and isotopic geochemical analysis of the samples taken from Mt Geryon Sill will provide sufficient data to develop a confident model for the origin of the magma source.

On the basis of the petrology, bulk rock and mineral geochemistry it is concluded that the mechanisms of differentiation are crystal fractionation and crystal movement through crystal settling and convection, possibly driven by roofward heat loss. The crystal fractionation process is controlled by the crystallisation of Ca-rich pyroxene and plagioclase. Temperature-fO_2 phase equilibrium data from this study suggest that the magma source is most likely to be from a setting similar to that of MORB and/or OIB rather than sub-arc. Establishing the setting for the emplacement of the Tasmanian dolerites will contribute to a greater understanding of the Jurassic large igneous province that spanned the margin of Gondwana.

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*Eds note: I couldn't resist putting this one in, even though it is a bit outside the topic. Miriam recently completed her honours thesis at ANU. She climbed and abseiled Mt Geryon, collecting samples approximately every 10 m through the 400 m thickness of the sill. Her findings have major implications for the nature and progression of the breakup of Gondwanaland and the nature of volcanism along this suture.

UPCOMING CONFERENCES

(gleaned from IAVCEI News, Volcano Listserv, TAG and other sources)

***AQUA (Australian Quaternary Association) Conference**, Southcombe Lodge, Port Fairy, Victoria. February 5-9 2001. Contact: Simon Haberle, School of Geography and Environmental Science, PO Box 11A, Monash University, VIC 3800, email: simon.haberle@arts.monash.edu.au, Ph: (03) 9905 2932, Fax: (03) 9905 2948, WWW: http://www.arts.monash.edu.au/ges/research/conference.html.

IAVCEI "Cities on Volcanoes 2" Workshop, Auckland New Zealand. February 12-18 2001. Contact: Secretary, Cities on Volcanoes 2, Wairakei Research Centre, Private Bag 2000 Taupo, New Zealand. Fax: (64) 7374 8199, email: citiesonvolc2@gns.cri.nz, WWW: http://www.gns.cri.nz/news/conference/cities.html

European Union of Geosciences meeting, Strasbourg, France. April 8-12 2001. Contact: EUG Office – Registration, 5 rue René Descartes, 67084 Strasbourg Cedex – France, Fax: 33 (0)3 88 60 38 87, WWW: http://eost.u-strasbg.fr/EUG/.

XXVI General Assembly of the European Geophysical Society, Nice (France). March, 26 - 30, 2001. Includes numerous symposia on volcanic hazards, modelling and European volcanology. Contact EGS Office, Max-Planck-Str. 13, 37191 Katlenburg-Lindau, Germany, Tel: +49-5556-1440, Fax: +49-5556-4709, email: EGS@COPERNICUS.ORG, WWW: http://www.copernicus.org/EGS/EGS.html.

^Penrose Conference, Mammoth Lakes, California. June 7-12 2001. Contact: Kurt Knesel, Department of Earth Sciences, University of Queensland, St. Lucia, Brisbane, QLD 4072, AUSTRALIA. Ph: 61-7-33659779, Fax: 61-7-33651277, email: k.knesel@earth.uq.edu.au.

IAVCEI 1902 Centennial Workshop, Mount Pelee, Martinique. May 8, 2002. Contact: Jean-Louis Cheminee and Georges Boudon, Observatories volcanologiques de l'IPGP, Boite 89 4 Place Jussieu, Paris Cedex 05 F075252, FRANCE. Ph: (33) 144272400, Fax: (33) 144272401, email: cheminee@ipgp.jussieu.fr, obs.volcanologiques@ipgp.jussieu.fr.

XXIII General Assembly of the IUGG—Sapporo, Japan (IUGG2003). June 30-July 11 2003. Contact: Seiya Uyeda, Chairman LOC, c/o International Communications Specialists, Inc. (ICS), 2-7-4 Sabo Kaikan-bekkan, Hirakawa-cho, Chiyoda-ku, Tokyo 102-8646 JAPAN. Fax: 81-3-3263-7077, email: iugg2003@ics-inc.co.jp. **Or** Dr Kiyoshi Suyehiro, General Secretary of LOC, XXIII General Assembly, Japan Marine Science and Technology Centre (JAMSTEC), 2-15 Natsushima-cho, Yokosuka 237-0061, JAPAN. Fax: 81-468-66-5541, email: IUGG_service@jamstec.go.jp, WWW: http://www.jamstec.go.jp/jamstec-e/iugg/index.html.

IGC Florence, Italy. August 16-26 2004. Contact: TBA.

* **AQUA pre-conference field trip through Western Victoria**

Quaternary History of the Western Plains flows & volcanoes - craters and pollen

Saturday 3rd, Sunday 4th & Monday 5th February 2001
Bernie Joyce, Peter Kershaw & Kate Harle

Two million years of landscape history across the Western Plains are reflected in a story of volcanic and neotectonic activity, sealevel change, changing climate recorded in pollen sequences and past lake levels, and the formation of volcanic soils and a predominantly grassland landscape. A long history of aboriginal occupation and a short history of European exploration and pastoral settlement have both included coping with problems of drought, flooding and salinity; a significant new land use change is the revegetation of the landscape including rapid development of blue gum plantations. The program is designed to be flexible, and arrangements can be made to join the field trip at any stage - just let us know (see note at the end).

Day 1 Saturday 3rd February 2001
The field trip will leave from the University of Melbourne (in or near the Geography car park) at lunchtime - 12 noon, cross the Werribee volcanic plains to Geelong and then through Inverleigh to arrive at Cressy, meet by arrangement any other vehicles travelling overland, and depart from Cressy at 2.30 pm. South past Lake Corangamite and lunette complexes, the Warrion Hill stony rises, Red Rock craters and the spectacular lookout, then other lakes including Lake Beeac and The Basins maar craters with recent lacustrine and pollen research, then through the Stony Rises of Mt Porndon, visiting the Floating Islands, to:

Overnight at Camperdown (see below)

Day 2 Sunday 4th February 2001
The second day will depart from Camperdown (meeting at the Camperdown Caravan Park - see below) and visit Bullenmerri and Gnotuk crater lakes to discuss lake level change, climate change and the pollen sequence, then east again to freshwater Lake Purrumbete, the Mt Porndon scoria pits and lava caves, and concluding at Mt Leura lookout for a sunset vista of Camperdown and the Volcanic Plains:

Overnight at Camperdown (see below)

Day 3 Monday 5th February 2001
The third day will depart from Camperdown and go west to volcanic maar Lake Terang and Pejark Marsh for pollen discussions, then Mt Noorat crater walk, Lake Keilambete and Jim Bowler's lake level sequence, Garvoc maar, Wangoom (more pollen) and Hopkins Falls, Warrnambool coast with past higher sea level at the mouth of

the Hopkins River (and the whale lookout), then past Tower Hill maar (brief lookout stop) to:

Southcombe Lodge at Port Fairy mid-afternoon for registration, and then evening BBQ.

Overnight Camperdown on Saturday & Sunday nights

Please arrange your own bookings - some suggestions are:
Old Leura Hotel, Camperdown - 1856 two-story hotel with iron lace verandahs & a ghost - 03 5593 1062
Camperdown Caravan Park - camping & cabins overlooking Lakes Bullenmerri & Gnotuk - 03 5593 1253
Or ring the Camperdown Information Centre 03 5593 3390

Counter teas or other evening arrangements by agreement on the day.

Note: more information can be obtained from the field trip leaders.

Please let Bernie Joyce know your travel plans so we can coordinate arrangements:
Tel: 03 8344 6523, Fax: 03 8344 7761, Email: ebj@unimelb.edu.au

^ Penrose Conference to address Longevity and Dynamics of Rhyolitic Magma Systems

A Geological Society of America Penrose Conference, "Longevity and Dynamics of Rhyolitic Magma Systems" will be held June 7-12, 2001, in Mammoth, California. Mammoth Mountain forms the southwest rim of the Long Valley caldera, one of three large Quaternary rhyolitic caldera centers in the United States. Long Valley, a site of recent volcanic unrest, lies at the heart of current debate over the mechanisms and time scales for the production, storage, and differentiation of rhyolite magma. Such information is critical to our understanding of fundamental geologic problems such as the formation and growth of Earth's continents and predicting volcanic hazards.

The purpose of the conference is to bring together petrologists, geochemists, volcanologists and geophysicists actively studying the generation and evolution of silicic magmas. We hope to try and resolve, or at least constrain, a number of very important and currently highly topical issues pertaining to the shallow-crustal evolution of large, typically caldera-forming, silicic magma bodies. These include:

What is a magma chamber-a large, long-lived fractionating liquid body or a "sleepy" crystal mush that gets kicked to life every so often, re-mobilizing existing material? A related issue is to what degree do plutons carry-forward, in some integrated way, the expression of this?

What do crystals really represent-phenocrysts vs. xenocrysts-and what 'memory' do they retain? Related to this issue are questions such as does crystal growth- and dissolution-zoning reflect protracted fractionation of a single magma body or remobilization and dispersal of crystal mush during injection of fresh magma into the subvolcanic system and how do crystals move in the magma system - or are the crystals effectively static in a moving magma system?

What is the efficacy of, and driving forces for, convection/mixing in silicic magmas? Can crystal disequilibrium features, such as chemical/isotopic zoning and dissolution surfaces, serve to discriminate between thermal convection and magma mixing?

What are the time scales needed to produce large, rhyolitic magma bodies? Recent work using $^{40}Ar/^{39}Ar$, Rb/Sr or U-series isotope data has led to the suggestion that rhyolite magmas in the Long Valley system are stored, following differentiation, for long (10^5-10^6) time scales. This contention has been disputed principally on the basis that it would be difficult to keep a body of magma thermally viable for such long periods, even if >500 km^3 volume. Alternative physical models have been proposed, such as remobilization of juvenile plutons or cumulate materials and ion microprobe work on zircons has variously upheld or contested the claims for long magma residence times. A key focus of the meeting will be to evaluate the different types of data available that bear on ages of magmatic events, and discuss their interpretations.

A limited number of keynote talks will serve to outline the current state of knowledge concerning the generation and evolution of large rhyolitic magma systems, and will set the foundation for evaluation of existing paradigms, development of new models, and discussion of future research directions. Most of the meeting will focus on poster sessions and group discussions. Mid-meeting field trips to selected Bishop Tuff and Sierran plutonic locations will serve to raise questions concerning limits and constraints on sampling and interpreting geochemical data from pyroclastic deposits based on our knowledge of how large silicic systems erupt, links between plutonic and volcanic environments, and the importance of recharge and mixing in magma evolution.

The conference is limited to approximately 50 participants to ensure a 'workshop-type' atmosphere focussed on manageable discussions. We encourage participation of graduate students working on silicic magma systems; partial student subsidies will be available. The registration fee, which will include lodging, some meals, field trips, and all other conference costs except personal incidentals, is not expected to exceed $750. Information on travel to the conference will be provided in the letter of invitation. Application deadline is January 1, 2000. Please send email application, to Kurt Knesel (k.knesel@earth.uq.edu.au), which should include a statement of your experience and interests as related to the themes of the conference, and a proposed title for poster presentation. All applicants are also encouraged to include a statement of what they perceive as the most critical questions that need resolution. Co-conveners are: Kurt Knesel, Department of Earth Sciences, University of Queensland, St Lucia, Brisbane, Qld 4072, Australia, k.knesel@earth.uq.edu.au, phone +61 7 33659779, fax+61-7-33651277; George Bergantz, Department of Geological Sciences, Office Box 351310, University of Washington, Seattle, WA 98195-1310, USA, bergantz@u.washington.edu, phone 206 685 4972, fax: 206 543 3836; Jon Davidson, Department of Earth and Space Sciences, UCLA, Los Angeles, CA 90095-1567, davidson@ess.ucla.edu, phone 310 206 3042, fax 310 825 2779. Website: http://www.geology.washington.edu/bergantz/penrose-2001.htm

LAVA ON THE WWW

Don't forget LAVA on the web at http://www.es.mq.edu.au/geology/volcan/. Here you can find the latest issue of *LAVA News* (including this one), information about the LAVA Committee, how to contact LAVA and relevant volcano WWW links. You can also download a PDF version of this issue of *LAVA News* so you can admire the beautiful colour pictures!

NEW BOOKS

Encyclopedia of Volcanoes. Editor-in-Chief H Sigurdsson, Assoc. Eds. B. Houghton, S. McNutt, H. Rymer & J. Stix. Academic Press. ISBN 0-12-643140-X, 1417 p, A$ 185.00. (Read Wally Johnsons review in IAVCEI News 2000 No. 2).

2001 IAVCEI Volcano Calendar. Order from http://www.browntrout.com or the Hawaiian Volcano Store http://www.volcanostore.com.

Exploring the Highest Sierra, by James G. Moore, "..covers ancient and recent volcanic and sub-volcanic features in the Sierra Nevada, and also the regional structures that engendered and localized volcanism. In addition, the recognition of volcanic features by the earliest explorers in the region is chronicled by a series of historic maps". Available from Stanford University Press (1-800 872-7423), US$17.95 (softcover), US$45.00 (hardcover).

Earthquakes and eruptions, the Smithsonian Institution's Global Volcanism Program CD-ROM. Available from: Office of Imaging, Printing & Photographic Services, Smithsonian Institution, 12th St. at Constitution Avenue NW, Washington, DC 20560-0644, Tel: 202-357-1933, Fax: 202-786-295. US$ 19.95 (incl. tax & shipping).

The Geological Society catalogue is now available from the Internet Bookshop as a PDF file. This means you can download and keep a copy on your computer for easy reference! See the website front page http://bookshop. geolsoc.org.uk. The catalogue includes books that are due to be published right up to December this year.

Most of which are not yet on the webshop until nearer their publication time.

AN APOLOGY

"Volcanic Stratigraphy: opening a can of worms" (Ali Raos, LAVA Committee, published in *LAVA News Vol. 2*) was actually substantially written by **Karin Orth**, CODES, with support from the CODES volcanology group. The previous editor apologises for this error, which was the result of a misunderstanding with Ali.

HELP WANTED:

Volunteers needed to report landslides for the Australian Landslide Database

See the database on the Web:
http://www.agso.gov.au

Click on "GEOHAZARDS", then "Landslides", then "Map landslides".

This database contains information on hundreds of Australian landslides. The information in it is used for public awareness activities, such as producing pamphlets and giving public lectures, and for landslide risk assessment.

We need ***volunteer landslide spotters*** to tell us about new landslides. Your information helps keep the database up-to-date, and you can check out your landslide on the AGSO (Australian Geological Survey Organisation) website. Volunteers will be given an official AGSO Landslide Spotters certificate, in appreciation of their help.

Please contact:

Dr Marion Leiba
AGSO
GPO Box 378
Canberra ACT 2601
Phone: 02-6249 9355 (work),
02-6231 9476 (home)
Fax: 02-6249 9911
email: Marion.Lieba@agso.gov.au

NEW A'ARTICLES

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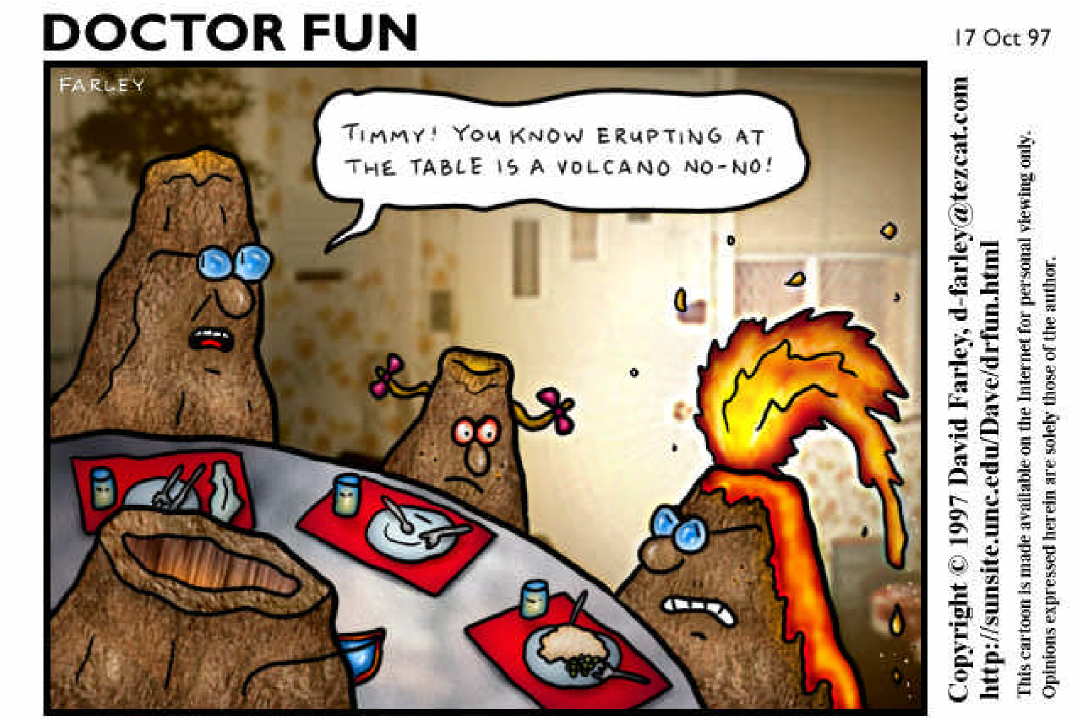
AND FINALLY, A PLEA...

We are attempting to publish **LAVA News** twice yearly, with publication every December and June (roughly). Would all members please take a small amount of time during their busy days to think about the next issue and forward any—*any*—material that you think might be of interest to the rest of the community. This includes articles, new books, new publications, media items and news from your places of work, be it personal, professional or student projects.

Articles can be forwarded to Sharon Allen or Liz Jagodzinski, LAVA co-chairs (email: Sharon.Allen@utas.edu.au, elizabeth.jagodzinski@agso.gov.au) or your editor, Ian Roach (ian.roach@

anu.edu.au), by **30 June 2001**.

Thanks to all the contributors this time around!



More trouble at the dinner table for the Volcano Family