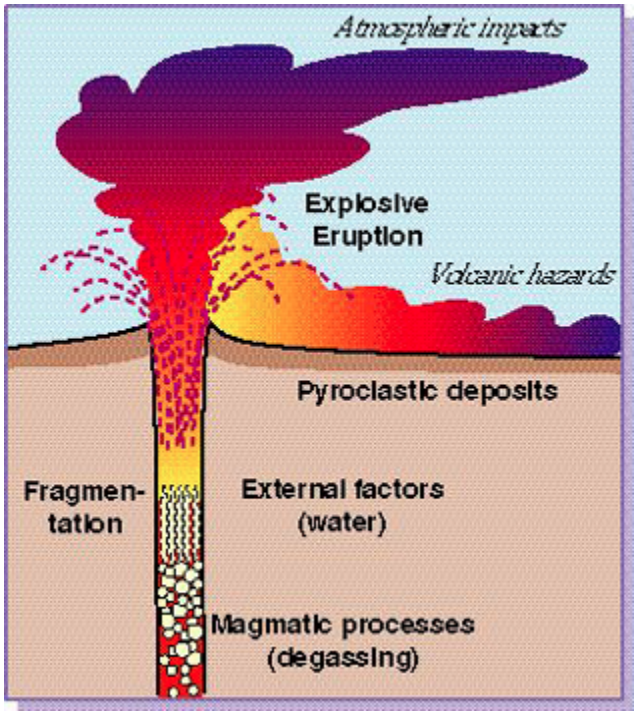

CEV 12/97 Newsletter

IAVCEI

COMMISSION ON EXPLOSIVE VOLCANISM

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1997-2001 CEV Leaders:

Michael Ort
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Largest explosive eruptions:

New results for the 27.8 Ma Fish Canyon Tuff and the La Garita caldera, San Juan volcanic field, Colorado

Recent field and petrologic studies in the central caldera cluster of the Oligocene San Juan volcanic field have shown that the 27.8-Ma Fish Canyon Tuff and associated La Garita caldera are more voluminous and complex than previously recognized. This tuff, long recognized as among the world's largest ash-flow sheets, consists of uniform phenocryst-rich dacite that spread widely beyond and ponded within its source caldera; the Fish Canyon represents a type example of "monotonous

intermediate" eruptions from a chamber that lacked compositional gradients. Among the 17 large (100->1000 km^3) Tertiary ash-flow sheets in the San Juan field (Steven and Lipman, 1976), the Fish Canyon Tuff is unique in its enormous volume (now estimated as about 5000 km^3, based on the great thickness of intracaldera tuff and extent of the outflow), compositional uniformity (67.5%-68.5% SiO_2), high phenocryst content (35%-50%), and near-solidus phenocryst assemblage (plagioclase, sanidine, quartz, biotite, hornblende, sphene, apatite, zircon, Fe-Ti oxides). It is the only San Juan ash-flow sheet containing phenocrystic hornblende without augite. Despite its volume, the entire tuff sheet forms a single cooling unit. Although dacitic in bulk composition because of high phenocryst content, the matrix is rhyolitic (75%-76% SiO_2).

The Fish Canyon Tuff, La Garita caldera, and newly identified precaldera lava-like rocks were the focus of an informal four-day field workshop in early September 1997, involving 18 participants from 5 countries.

Precaldera lava-like rocks

A large precaldera lava-like body (30 km across, to 0.5-1 km thick, and 200-300 km^3 volume) along the recently recognized south margin of the La Garita caldera, and a small postcaldera lava flow in the northern moat, are compositionally indistinguishable from the ash-flow tuff, documenting variable eruptive processes from a large magma body. The precaldera dacite was previously interpreted as thick welded Fish Canyon Tuff (Steven and Lipman, 1976) ponded within an existing caldera, but it lacks lithic fragments and is locally flow layered. The dacite displays complex textures and structures that are transitional between typical silicic lavas and pyroclastic deposits. Initial eruptions were pumiceous, and the main dacite body contains widespread fragmental textures and distinctive "blob" breccias (rounded fragments to 2 m), indicative of initial eruption as relatively dense spatter in a poorly sorted fragmental matrix. No evidence has been found to indicate initial eruption as fluid lava, even though some proximal material is so strongly flow layered that fragmental textures have been obliterated. Gravitational spreading has locally generated large ramp structures (dips to 70°) in distal deposits. We interpret the lava-like rocks as the product of low-energy pyroclastic fountaining, rather than fluidal lava. Although petrologically diverse lavas and tuffs were erupted widely in the San Juan region before Fish Canyon eruptions, the lava-like dacite is the only compositional precursor to the voluminous Fish Canyon ash flows.

Detailed mapping of the precaldera lava-like dacite has documented that complex faulting accompanied eruption of this enigmatic body. Although not yet completely analyzed, these faults define a broad complex north-trending graben that was beheaded by subsequent subsidence of the La Garita caldera. Many of the graben faults cut the lava-like dacite but are overlain unconformably by the succeeding Fish Canyon Tuff. Along some, the dacite thins abruptly or is depositional against fault-line scarps. Along other faults, the dacite is variably disrupted, locally showing extreme brecciation or intense rheomorphic flowage. Overall, these faults define modest piecemeal block-fault subsidence associated with eruption of the dacite, the first such subsidence geometry recognized in the San Juan region. Notably, the piecemeal graben structure is associated with low-energy pyroclastic activity, rather than major ash-flow eruption and caldera subsidence.

Generalized geologic map of the La Garita caldera

Figure 1:

Generalized geologic map of the La Garita caldera

La Garita caldera

The La Garita caldera is larger than previously recognized (35x75 km), more elongate, and segmented. This caldera was formerly interpreted as about 40x30 km, with its south margin concealed beneath younger caldera subsidences in the Creede area (Steven and Lipman, 1976). In the summer of 1995, however, we found the south margin of the La Garita caldera well exposed within the rugged Weminuche Wilderness, 30-35 km south of its previously inferred position. Eruptive activity, depths of subsidence, and postcollapse resurgence varied among three sectors, even though only single outflow tuff sheet is associated with the caldera. In each sector, outflow tuff is truncated along the caldera walls against which the intracaldera tuff wedges out depositionally. Both intracaldera and outflow tuffs have the same phenocryst assemblage, mineral compositions, paleomagnetic polarity, isotopic ages, and elemental compositions, providing for confident correlation, along with the stratigraphic constraints.

In the northern caldera sector, the La Garita Mountains are a resurgently uplifted block of intracaldera Fish Canyon Tuff more than 1200 m thick without exposed basal contacts (Steven and Lipman, 1976). Intracaldera tuff is strongly indurated and oxidized red-brown, in comparison to the light gray outflow, and it contains larger and more coarsely porphyritic pumice lenses (10-20 cm). Along the western side of the central sector, a tilted block that may represent another locus of resurgence exposes an incomplete section of intracaldera tuff (>350 m) resting on older volcanic units of the caldera floor. Erosional levels in the southern sector, as in the northern, expose thick intracaldera tuff (>800 m) without reaching the caldera floor. Resurgence is absent in the southern sector; instead, linear faults recurrently disrupted the caldera fill, which includes andesitic lavas (Huerto Formation) that flooded the southern sector after collapse. The "new improved" La Garita caldera completely encloses the caldera sources of the 7 major ash-flow sheets erupted from the central San Juan field during the next 1.5 m.y.

Petrology

Petrologic features of the Fish Canyon Tuff and associated lava-like rocks are also more complex than previously described. Re-study of the Fish Canyon Tuff demonstrates that erupted homogeneous dacite (68- 69% SiO_2) was in contact with subjacent andesitic magma, and feldspar-liquid disequilibrium is comparable to that which characterizes strikingly resorbed quartz. The latter observation explains formerly controversial thermo-barometric discrepancies, may pose problems for the utilization of Fish Canyon minerals as geochronologic standards, and places important constraints on the origin of the Fish Canyon magma body. Large poikilitic sanidines enclose plagioclase, quartz, and other minerals; grain-boundary melting along contacts with these inclusions is frequently at an advanced stage. Partial diffusive equilibration adjacent to melt pockets, and along sanidine grain margins, has produced large compositional gradients that truncate pre-existing zoning in sanidine. Rare, intact plagioclase-sanidine contacts apparently preserve up-temperature diffusion gradients superimposed on down-temperature gradients. Such features indicate that the Fish Canyon magma reservoir formed either by rapid, shallow partial fusion of an existing batholith, or by remelting of the solidified margins of a long-lived magma chamber. Quartz resorption reflects a major thermal event, not a response to decreasing pressure during magma ascent (contraction of SiO_2 stability relative to feldspars). Despite uniform bulk-sample compositions of the lava-like dacite and main Fish Canyon Tuff, a mafic component was involved. Most of the precaldera dacite is homogeneous, but rare andesitic blebs (1-5 cm diameter, 58% SiO_2) and concentrations of finely porphyritic mafic minerals smeared along flow layers provide evidence for mingling with andesitic magma prior to eruption. The first postcollapse volcanism around south and west margins of the caldera (voluminous lavas of the Huerto Andesite) also tapped mafic compositions.

Sparse small fragments of comagmatic granophyre in late-erupted intracaldera tuff and postcaldera lava, having mineral compositions indistinguishable from phenocrysts in the tuff and precaldera lava-like rocks, record complex events in the Fish Canyon chamber just prior to and during eruption (Lipman et al., in press). Sanidine phenocrysts in the granophyre preserve zoning evidence of mingling with andesitic magma, then shattering by decompression and volatile loss accompanying early Fish Canyon eruptions before overgrowth by granophyre. The textural and chemical disequilibria indicate that the eruption resulted from batholith-scale remobilization of a shallow subvolcanic chamber, triggered by mafic magma replenishment, and erupted before textural or

chemical equilibrium were re-established, contrary to previous interpretations of magma storage and phenocryst growth in the lower crust.

References:

Lipman, P.W., Dungan, M.A., Bachmann, O (1997) Comagmatic granophyric granite in the Fish Canyon Tuff, Colorado: implications for magma-chamber processes during a large ash-flow eruption. Geology, in press

Steven, T.A., and P.W. Lipman (1976) Calderas of the San Juan volcanic field, southwestern Colorado. U.S. Geol. Survey Prof. Paper 958, 35 p.

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La Garita Caldera
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last modified: Sept. 22, 1997

URL: http://vishnu.glg.nau.edu/cev

Peperites and Peperites

By C. Leah Moore

Peperites form when hot magma interacts with unconsolidated water-saturated sediment forming a rock with a clastic texture (Fisher 1960, Williams & McBirney 1979). There is some debate about whether the genetic term peperite should be used (Cas & Wright 1988 p 361, McPhie et al., 1993 p 58), or whether non-genetic descriptive nomenclature should be used for a suspected peperite. This is because the range of magma disruption processes that take place during peperite formation includes: phreatic (steam) explosion; pyroclastic (bubble burst) explosion; autobrecciation; quench fragmentation; or, a combination of these, and specific evidence of the mechanism of formation may be unclear.

In subaqueous volcanic successions peperites are relatively common. They form where magma intrudes or flows over water-saturated pelagic or hemipelagic sediments or where it intrudes its own, or a pre-existing, unconsolidated hyaloclastite pile. At mid-bathyal to bathyal water depths, volatile exsolution and bubble expansion within magma is supressed by the combined lithostatic and hydrostatic confining pressure (Kokelaar 1986, Cas 1992). This may prevent development of a stable

vapour film around intruding magma, allowing water and magma to interact. Hence, the disruption of magma is dominated by quench fragmentation rather than pyroclastic (bubble burst) disaggregation (Cas 1992). For the same reason, expansion of pockets of water and sediment trapped within magma during intrusion will be suppressed. Thus magma disruption by this mechanism will be much less significant than in shallow water or at the land surface.

Although the margins of such intrusive bodies can be highly irregular (e.g. Hanson & Schweickert 1982, Hanson & Wilson 1993, Goto & McPhie 1996), and fluidisation of sediment at the contact may cause some mixing (Kokelaar 1982), magma quenching generates peperites dominated by angular polygonal clast shapes (e.g. Heiken & Wohletz, 1985; Busby-Spera & White, 1987; Moore et al., 1996). Frequently these clasts form a jig-saw fit texture, where quenched clasts are not displaced far from adjacent clasts and it is possible to fit clast shapes back together. Clasts can be vesicular and where quench fractures cut vesicle walls, irregular clast margins will form, but the fragmentation in this case is not due to bubble burst.

In Miocene subaqueous volcanic sequences in south-west Hokkaido Japan there are a number of localities where this type of peperite has formed. At Kabuto Cape basaltic andesite lobes 2 m to 5 m across have intruded water-saturated hyaloclastite and have peperitic margins (Moore et al., 1996). Peperite at Sakazuki River (Yamagishi 1981) formed where hornblende andesite intruded fine-grained hemipelagic sediments. An older example is preserved in the Devonian Bunga Beds in southwestern New South Wales, Australia. Here, pale-coloured rhyolitic magma has intruded wet unconsolidated deep marine muds (Cas et al., 1990).

These volcaniclastic rocks differ from their terrestrial and shallow marine equivalents. Quench fragmentation textures are still observed in peperites formed at shallow depths, but the interaction of magma and sediment is more strongly influenced by the exsolution of volatiles and growth of bubbles in and around the magma. At shallow depths, volatiles are able to expand and explosively disrupt the magma (e.g. maar volcanoes), thereby mixing magma and sediment. Bubble growth may cause inflation of the peperitic sediment after mingling has taken place. If a stable vapour film can develop around intruding magma (Kokelaar 1986), quenching may not be the dominant process in peperite clast formation. In this environment the expansion of pockets of water and sediment trapped within the magma may cause explosive disruption of the magma (Kokelaar 1986).

At Ukinrek Maars, Alaska, peperite of this kind has formed when mafic magma interacted with sand-sized to granular volcanic sediment, phreatomagmatic ejecta from the maar volcanoes. What makes this rock unusual is not the mingling of hot fluidal lava with unconsolidated water-saturated sediments, but the fact that the rock is vesiculated throughout. The lava was actively vesiculating at the time of intrusion into the sediment and it appears that the vesicles migrated through the lava-sediment mixture, causing the whole rock to inflate. Some parts of the peperite show a clear globular mingling of lava and sediment, similar to the texture described by Busby & White (1987) for peperite from Punta China, Baja California, Mexico. Elsewhere in the specimen it is difficult to distinguish whether the granular material is sediment or a sediment-lava mixture. Thin section work would clarify the degree to which the process of mixture versus mingling was dominant.

There are a number of comprehensive reviews of our understanding of the genesis of peperite (e.g. Cas & Wright, 1988 p 43-46, p 54-55; McPhie et al. 1993 p 57-58). However, apart from a discussion

based on the work of Kokelaar (1982, 1986) on the expansion of volatiles at depth in the water column with respect to development of a vapour film around intruding magma, and expansion of trapped volatiles in pockets in the magma (Cas 1992), and the relationship between peperite clast morphology and the nature of the enclosing sediment (Busby-Spera & White 1987), there has been limited discussion of the mechanisms of peperite (or hyaloclastite) formation. As vesiculation theory develops (e.g. Cashman & Mangan 1994, Mader et al 1994, Klug & Cashman 1996), general understanding of magma disruption is evolving, and understanding of the mechanisms of peperite genesis may be refined.

References

Busby-Spera C. J. & White J. D. L. (1987) Variation in peperite textures associated with differing host-sediment properties. Bulletin of Volcanology 49, p 765-775.

Cas R. A. F., Bull S. W., Clifford B. A., Wright J. V. (1990) Subaqueous, rhyolitic dome-top cones: a model based on the Devonian Bunga Beds, southeastern Australia. Geology Magazine 120, p 471-486.

Cas R. A. F. (1992) Submarine volcanism: eruption styles, products and relevance to understanding the host-rock successions to volcanic-hosted massive sulfide deposits. Economic Geology 87, p 511-541.

Cashman K. V. & Mangan M. T. (1994) Physical aspects of magmatic degassing II. Constraints on vesiculation processes from textural studies of eruptive products. In: Carroll M. R., Holloway J. R. (eds) Volatiles in Magmas. Reviews in Mineralogy 30, p 447-478.

Fisher R. V. (1960) Classification of Volcanic Breccias. Geological Society of America Bulletin 71, p 973-982.

Goto Y. & McPhie J. (1996) A Miocene basanitic peperitic dyke at Stanley, northwestern Tasmania, Australia. Journal of Volcanology and Geothermal Research 74, p 111-120.

Hanson R. E. & Schweickert R. A. (1982) Chilling and brecciation of a Devoniam rhyolitic sill intruded into wet sediments, northern Sierra Nevada, California. Journal of Geology 90, p 717-724.

Hanson R. E. & Wilson T. J. (1993) Large scale rhyolitic peperites (Jurassic, southern Chile). Journal of Volcanology and Geothermal Research 54, p 247-264.

Heiken G. H. & Wohletz K. (1985) Volcanic Ash. University of California Press, Berkeley, pp 246.

Klug C. & Cashman K. V. (1996) Permeability development in vesiculating magmas: implications for fragmentation.

Kokelaar B. P. (1982) Fluidization of wet sediments during the emplacement and cooling of various igneous bodies. Journal of the Geological Society of London 139, p 21-33.

Kokelaar B. P. (1986) Magma-water interactions in subaqueous and emergent basaltic volcanism.

Bulletin of Volcanology 48, p 275-289.

Mader H. M., Zhang Y., Phillips J. C., Sparks R. S. J., Sturtevant B., Stolper E. (1994) Experimental simulations of explosive degassing of magma. Nature 372, p 85-88.

Moore C. L., Cas R. A. F., Scutter C. & Yamagishi H. (1996) Fragmentation and Depositional Processes During Construction of A Submarine Volcanic Edifice, Kabuto Cape, Hokkaido, Japan. Eos Transactions Supplement v 77, No. 22, p W125.

Williams H. & McBirney A. R. (1979) Volcanology. Freeman, Cooper and Co., San Francisco, pp 397.

Yamagishi H. (1981) Geology of the Shakotan Peninsula, Hokkaido, Japan. Reprt of the Geological Survey of Hokkaido 52, pp 29.

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Bringing Volcanology into the City -- IUGG Activities

by Greg Valentine (gav@lanl.gov) and Grant Heiken (heiken@lanl.gov)

The proximity of volcanoes such as Popocateptl (Mexico) and the Campi Flegrei (Italy) to densely-populated urban areas has resulted in a growing focus in volcanology toward the integration of volcanic hazards studies with data and models on urban infrastructure (e.g., transportation, telecommunications, water and sewage distribution), and with the social and political structures of cities, in order to mitigate the effects of eruptions on populations. The "Cities on Volcanoes" conference scheduled for June 1998 is a good example of this new focus within IAVCEI. IAVCEI is part of the International Union of Geodesy and Geophysics (IUGG), the umbrella organization for many different geophysical disciplines. The purpose of this article is to briefly describe one of the possible directions that IUGG might take with regard to urban problems, so that we as CEV/IAVCEI can begin thinking of contributions that we might make to the larger picture.

IUGG has established a Megacities Council (Chair: Uri Shamir, Water Research Institute, Haifa, Israel) that will plan conferences and activities for the Union. We proposed the following action for the Council and for the Union in general: designate the first decade of the new millennium to be a time when IUGG focuses its interdisciplinary resources on urban issues. The approach to this would be modeled after IAVCEI's highly successful Decade Volcano program (led by Chris Newhall, USGS). In our proposal, each IUGG member nation could nominate an urban center as a "Decade City." Our suggested goals, selection criteria, and the role of IUGG in the Decade City program are:

Goals:

- Focus the geophysical, atmospheric, hydrologic, and geological sciences on interdisciplinary

approaches to solving urban problems of sustainability and vulnerability.
- Build bridges to the infrastructure community, the economic and social sciences, and to decision makers, that strengthen the relevance of the earth sciences to society.

Criteria for selection of Decade Cities:

- Existing or impending severe environmental and/or natural hazard problems.
- Large population and related infrastructure.
- High potential for focused study to have significant impact on quality of life and sustainability.
- High potential for positive response and collaboration between researchers, agencies that develop and maintain infrastructure, and decision makers.
- Local researchers propose, participate in, and help lead program, for their city.

An extensive series of workshops and documents would result from this plan, as well as symposia at IUGG General Assemblies. CEV members should play a critical role in Decade Cities that are threatened by nearby volcanoes. We would like to hear your ideas and criticisms of the Decade Cities proposal which, at this point is just in the initial stages of discussion.

IAVCEI commission on arc volcanism:

A proposal from Jon Davidson

(University of California at Los Angeles)

Objective:

To foster interaction and communication between scientists with an interest in volcanism at subduction zones. This may range from volcanological issues (including hazards, and therefore with strong links to the commission on explosive volcanism) to more academic concerns such as the identification of source contributions to subduction related magmas, mass balancing fluxes across convergent margins, and evaluation of the role of such magmatism in the evolution of crust and mantle.

Activities

1. Informal interaction. Provide a forum (through the internet, perhaps also with a hard copy news letter, such as the "LIP Reader") for
    - dissemination of information (meetings, databases, other web sites, important developments/ discoveries/ publications) by organizers (see personnel below)
    - discussion of scientific issues, through electronic bulletin board/ discussion group.
2. Structured interaction. Organize meetings focused on aspects of subduction-related volcanism, both as special sessions at international meetings (IAVCEI, IUGG, AGU, EUG, GSA...) and as

independent "workshop" style meetings (a model for which might be the forthcoming "State of the Arc" meeting in Adelaide, February 1997). The latter would ideally incorporate a strong field component and involve field trips and outcrop discussions. They could be combined with meetings of the Explosive Volcanism Commission, or the (concomitantly forming) Ocean Island Magmatism Commission, either through overlap or by complete integration.

3. Serve as an advocacy group independent of funding organizations to develop and endorse research endeavors involving subduction related magmatism. In recent years meetings such as "MARGINS" in Austin, 1994 and "SUBCON" in Catalina, 1995 have brought together groups of scientists such as we would hope to target, to discuss what we know and hope to know in arc magmatism, and to propose collaborative research efforts.

Personnel

I am willing to volunteer as responsible for the commission for a few years, and have one or two colleagues willing to help me out. The commission could be managed much as other IAVCEI groups with a leader and secretary or co-leaders - and perhaps a steering committee. The latter would ensure international representation.

I understand that IAVCEI would rather have commission leadership which crosses international boundaries, and will propose leadership accordingly.

Book Review

W.A. Duffield's review of

VOLCANOES

CRUCIBLES OF CHANGE

By: Richard V. Fisher, Grant Heiken and Jeffrey B. Hulen

With this book (hereafter Volcanoes), Fisher, Heiken and Hulen have produced a marvelous addition to the literature of volcanology. In the course of 15 chapters that fill 285 printed pages, they cover topics as diverse as the why-where-and-what of volcanoes and their eruptive products, volcano hazards and related politics, and various linkages among volcanoes, World War II, viticulture, construction materials, religion, and human origins. An appendix even offers suggestions for worldwide destinations where the adventuresome traveler can experience volcanoes and their related treats and treacheries. Volcanoes is so wide ranging that, by the time I reached the section on myths, legends and religion, I rather expected to find an eruption story about Elvis. If the face and form of

Pele are evident in so many eruption clouds and meandering lava channels at Hawaii, why not the figure of other volcanic personalities? But even lacking the mention of Elvis, there is something for nearly everybody in this book.

The first nine chapters cover conventional topics of volcanology, with sorties into the increasingly explored realm of the politics of dealing with volcanic hazards outside the shelter of purely technical volcanology. The stage is initially set by recounting the story of the 1980 eruptions of Mount St. Helens. Following acts educate the reader in relations between volcanism and plate tectonics; in the elemental building blocks of magma, minerals and eruptive products; and in types of volcanoes and their styles of volcanism. Descriptions of eruptive style and related products emphasize the hazard aspects of volcanism. For amateur and professional volcanologists alike, this is all pretty familiar material. It is also background necessary for helping to understand the derivative topics that follow.

Chapter ten delves into the nether regions of volcanology -- topics that are fascinating but probably too anecdotal and subjective to be considered the stuff of science. Specifically, volcano-related myths, legends and religions are explored from Greek and Roman times of three to two thousand years ago, on through to various contemporary cultures. Volcano legends abound, of course, and as the authors point out, some seem to contain the seeds of truth as we (think we) know it at the autumn of the twentieth century AD. Though fundamentally matters of faith rather than fact, I believe that mythical aspects of volcanology serve the dual purposes of adding art and spice to our science as well as being reminders that our knowledge of volcanoes is imperfect and incomplete.

Chapters eleven through thirteen deal with what can be categorized broadly as applied volcanology -- how humans use volcanoes and their products. Descriptions of volcanic materials used in construction emphasize variously consolidated tuffs both as quarried stones and as in-place carvings. A shopping list of uses for fragmental and chemically altered volcanic products ends with kitty litter, something not usually alluded to in text books yet high in the consciousness of cat fanciers. The must-mention topic of rich volcanic soils is covered through discussion of such tasty agricultural products as wine and coffee. And the benefits of thermal energy associated with volcanoes are chronicled through discussion of geothermal resources and the mineral-resource byproducts of hydrothermal systems powered by magmatic heat associated with volcanoes.

Chapter fourteen depicts volcanic rocks as 'Guardians of History', through their roles of burial and preservation of peoples and artifacts. The principal examples described are at Ceren (buried by Laguna Volcano in El Salvador during the sixth century AD), Pompeii and Herculaneum (buried by Vesuvius in 79 AD), Akrotiri (buried by Santorini about 3,600 years ago), and multiple sites within the Ethiopian Rift Valley where volcanoes and very ancient humans coexisted.

The fifteenth and final chapter returns to the theme of volcano hazards and their mitigation. Case studies from the fairly recent historic record highlight eruptions of and lessons learned from Mount St. Helens (1980), El Chichon (1982), Nevado del Ruiz (1985), Mount Pinatubo (1991), and Galeras (1993). A table of volcano-caused human deaths since 1500 AD and deaths by type of volcanic activity provide sobering and instructive statistics. The closing paragraphs describe the antics of Dante, an experimental robot designed to visit and measure and sample volcanoes, in place of at-risk humans.

Volcanoes is not a classical textbook, though a clever professor could put it to effective classroom use. The book is written for a non-technical audience, and I believe that it squarely hits the intended target. The writing is uniformly readable, and in spite (or perhaps because) of an easy going and chatty style, everything from somewhat technical aspects of volcanoes to fanciful tales of how the lives of volcanoes and people are intertwined is pretty understandable. The liberal use of vignettes, drawn from the authors' personal experiences, adds a personal touch and a human dimension too often lacking in Earth Science literature. I often found myself wanting to hear more of these stories, and to be able to add some volcano adventures of my own.

However, what is a book review if it lacks criticism? Accordingly, I have identified a few nits to pick. Volcanoes is a collection of essays linked by sometimes-clumsy, chapter-ending paragraphs, which tend to emphasize that chapter-to-chapter continuity is weak. On page 31, mantle is used synonymously with asthenosphere and crust synonymously with lithosphere, serious no-noes in the Earth Science classroom. On pages 80 and 81, following a detailed description of how a ship and crew were destroyed by a volcanic eruption at sea, the authors write, 'There is no need to worry about being engulfed in a volcanic eruption during your next ocean cruise.' I am not reassured by the juxtaposition of thoughts here. Somewhat similarly, chapter five includes repeated use of the phrase 'volcanic hurricane' and offers a comparison of the degree of devastation expectable from a volcanic versus an atmospheric hurricane. Then the authors add confusion by writing that a volcanic hurricane is 'in no way related to the more familiar atmospheric hurricane.' Lack of reference to the work of Robert L. Smith in the rather long section (pages 102-111) explaining the development of fundamental concepts behind welded tuffs and large silicic calderas seems a notable oversight. The authors should remember that Pele is the Hawaiian volcano goddess and that Madame Pele, wherever she may reside, probably is far less reputable. In chapter fourteen, the implication that the remains and artifacts of ancient humans recovered from the Ethiopian Rift Valley were buried and thereby preserved by volcanic deposits is somewhat misleading. Most of these fossils are contained in sedimentary deposits, whereas interlayered volcanic rocks provide materials that can be used to determine isotopic ages. Finally, if the book is ever reprinted, the authors should strive to find a way to include some color photographs and illustrations.

In closing, I recommend that you forget the above nits and buy the book. The publisher advertises cloth copies of Volcanoes for $31.50 plus postage and handling. Check out the address, http://www.amazon.com, for the same book at about $25. You may have your own preferred electronic bookstore. Then, new book in hand, put on your favorite pair of stone-washed jeans, relax in your well insulated cinder-block house, nibble at geothermally-cooked fish washed down with a chilled lava-label white wine and have a good read! Among other fascinating facts, you'll learn that World War II beaches of Iwo Jima are now about 10 meters above sea level, because they are riding atop the active shallow magma reservoir of a resurgent caldera. If you are the worrying kind, don't do your reading at Iwo Jima or at Pozzuoli.

Book Review

by T. Koyaguchi

Fire and Mud: Eruptions and Lahars of Mount Pinatubo, Philippines

C.G. Newhall and R.S. Punongbayan, Editors
University of Washington Press, 1996

This book is a monograph which consists of more than 60 papers on the 1991 eruption of Mount Pinatubo and subsequent widespread lahars. It is divided into the following 8 sections:

1. Volcanic drama human drama
2. Ancient and modern history
3. Geophysical unrest
4. A volcanic system
5. Observation and reconstructions: the 1991-92 eruptions
6. A story in the rocks
7. Lahars, lahars and more lahars
8. Selected impacts

The book is well-organized and I personally have an impression that the qualities of individual papers are satisfactory owing to peer critical reviews. Some of the papers look immature in the sense that they are still in progress and the ideas and interpretations have not been fully supported by a complete set of data. This is because, as one of the editors (Chris Newhall) stated in the preface, "the goal of this book was to balance timeliness with completeness." Anyway, most of the volcanologists would be interested in what happened in the eruption at first, and this book is certainly useful to see what happened in the eruption.

From an explosive volcanism perspective, the Pinatubo 1991 eruption is particularly interesting, because data of new methods (satellite images, acoustic wave monitoring data and other remote sensing data) are available in addition to ordinary geological and geophysical data. Since the 1970s, a number of models related to explosive volcanism have been proposed. Comparison among these data of different methods allows us to assess these current models in a quantitative fashion and makes it possible to refine them.

Because this book covers such a wide range of topics of geophysics, geochemistry, petrology and geology including the new approaches, the readers can combine the results of different papers written by different authors in the readers' own way and may be able to gain new insights which even the authors have not noticed. For example, if you wish to carry out calculations of eruption dynamics on the basis of the current models, you can get all the necessary parameters in this book alone; you can find magma temperature and volatile content in petrological, and geochemical papers and dimension of magma plumbing system in geophysical papers, and so on. You can also compare your own results of the calculations with geological and geophysical observations which are described in this book. Because individual papers are based on different views, some results may agree and others may be apparently contradictory. However, I do not think that it is very difficult for the readers to find a new

resolution even if they encounter such a contradiction, because the editors made an incredible effort to organize the book by reconciling the different views in the most constructive way.

In summary, there are many lessons which we should learn from this eruption and this monograph is a precious record of what we have learned and it is also useful as a source of new ideas.

Future activities

Plans for the future include workshops in the Andes (ignimbrites and debris avalanches), in SE Australia (water-magma interaction), and in Italy (shallow submarine volcanism). Plans for activities at the IAVCEI International Volcanological Congress 1998 (Magmatic Diversity: Volcanoes and their Roots) in South Africa are presently being developed, with a planned symposium on the relationship between kimberlites, maars, and diatremes.

Announcement of CEV Symposium at South Africa IVC Meeting

Kimberlites, Maars, and Diatremes

For decades, there has been considerable debate about the relationship between kimberlites, maars, and diatremes. Evidence of the involvement of phreatic water in maars became quite strong by the early 1970's, but do kimberlites and diatremes all form through phreatic and phreatomagmatic explosions? Also, what about the common association of CO2-rich magmas with maars and diatremes? This symposium is proposed to provide the opportunity for workers in this area to debate the processes involved in these volcanoes, and the similarities and differences between them. We intend to allow time for general discussion of the issues at the end of each session.

CEV Field Workshop Proposals for July 1999 in United Kingdom

from Mike Branney and Peter Kokelaar

We are considering the possibility of organising a field-based CEV workshop, to run before or after the July 1999 IUGG meeting at Birmingham, England: (1) Inside silicic calderas. A 10-day field workshop visiting Snowdon caldera in Wales, Scafell caldera in the English Lake District, and Glencoe caldera in Scotland. These calderas have been uplifted and deeply eroded, beautifully exposing their internal structure, caldera faults, conduits, ignimbrite fills, and underlying caldera floors, such as are generally obscured at modern calderas. Themes of the workshop would include (i) nature and controls of contrasting styles of collapse; (ii) discrimination of tectonic influences; (iii) processes and products of hydrovolcanism in flooded calderas; (iv) controls on emplacement of lava-like ignimbrite lithofacies in intracaldera settings; (v) role played by intrusion in caldera fills.

(2) An alternative 8-day workshop would consider sedimentation associated with major explosive

eruptions in marine, volcanic island, caldera lake and alluvial settings, at Scafell and Snowdon calderas.

We estimate that the 10-day workshop would cost about US $800, for return transport from the Birmingham IUGG meeting venue, field transport, and simple hotel accomodation. Both workshops would involve strenuous walking in rough terrane, and informal evening seminars, for no more than 30 participants.

If you might be interested to participate in either workshop, please email Mike Branney at mjb26@le.ac.uk as soon as possible but no later than mid March. Please state your specific interests and your preferences as regards timing in relation to the Birmingham meeting, so that we can gauge if there is sufficient initial interest to proceed.

Mike Branney & Peter Kokelaar

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The Cities on Volcanoes conference is set for June 28 to July 4, 1998 in Rome and Napoli, Italy. For more information: Cities on Volcanoes Second Circular

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8TH CONGRESS OF THE INTERNATIONAL ASSOCIATION OF ENGINEERING GEOLOGY AND THE ENVIRONMENT

Vancouver, British Columbia, Canada
21-25 September 1998

The International Association of Engineering Geology and the Environment (IAEG) and the Canadian Geotechnical Society (CGS) are proud to host the 8th Congress of the IAEG. It promises to be one of the best engineering geology congresses ever.

The theme, "A Global View from the Pacific Rim", will bring together about 750 experts, practitioners, and students of engineering geology and related disciplines. They will share their knowledge and experience to help promote a global view of engineering geology as seen from one of the most beautiful cities on the Pacific Rim.

Deadline for abstracts: 15 January 1998
Deadline for early registration: 15 April 1998

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INTERNATIONAL VOLCANOLOGICAL CONGRESS

Cape Town, South Africa
11-17 July 1998

For more information contact:
Secretariat, IVC '98
Department of Geological Sciences
University of Cape Town
Private Bag
Rondebosch 7701
Republic of South Africa
Fax: +27 21 650-3783
Or look us up on the web at: http://www.uct.ac.za/depts/ geolsci/ivc98/

Following are some symposia that are of particular interest to CEV members

Erupted and non-erupted granites

Convened by the IAVCEI Commission on Granites

This sub-symposium will be concerned with the production of silicic magma, causes and modes of eruption, the erupted/non-erupted ratio of silicic magmas, and their contribution to continental growth.

Convenors:
Bernard Bonin, Universite Paris-Sud, Paris, France
Email: bbonin@geol.u-psud.fr
Simon Milner, Geological Survey, Windhoek, Namibia
Email: simon@gsn200.gsn.mme.gov.na

Shan de Silva, Indiana State University, Terre Haute, Indiana, USA
Email: gesilva@scifac.indstate.edu

BETWEEN MAGMA SOURCE AND ERUPTION

This symposium is soliciting papers concerned with the mechanics and dynamics of magma during its ascent from source to surface. This includes topics such as the segregation of magma from mantle and crustal sources, the transport of magma through mantle and crust, the nature of magma chambers and their role in magma evolution, the exchange of heat and material with country rocks, and eruption processes. It is intended that the symposium will provide the opportunity to marry petrological, geochemical and geophysical observations of natural systems with numeric and analog modeling and to compare modern active systems with ancient equivalents.

Convenors:
Mike Watkeys, University of Natal, Durban, South Africa
Email: watkeys@geology.und.ac.za
Nick Arndt, UniversitŽ de Rennes, Rennes, France
Email: arndt@univ-rennes1.fr

PEPERITES: PROCESSES AND PRODUCTS OF MAGMA-SEDIMENT MIXING AND IMPLICATIONS FOR THE MECHANISMS OF EXPLOSIVE MAGMA-WATER INTERACTION

Convened jointly by the IAVCEI Commission on Volcanogenic Sediments and the Commission on Explosive Volcanism.

The symposium is concerned with the processes and products of the interaction and mixing of any magma type with any sediment type (wet or dry). We feel that peperites have been neglected, given the abundance of magma-sediment (usually wet sediment) interaction in both subaerial and submarine environments, and their potential importance as guides to the triggering and initial mechanisms of explosive magma-water interaction. We welcome any contributions that fall within this broad scope including field and microscopic textural studies and theoretical and physical modeling. We are particularly interested in any studies which have implications for the mechanisms of explosive magma-water interaction.

Convenors:
Ian Skilling, Rhodes University, Grahamstown, South Africa
Email: ips@rock.ru.ac.za
Cathy Busby, University of California at Santa Barbara, Santa Barbara, California, USA
Email: cathy@magic.geol.ucsb.edu

RELATIONSHIP BETWEEN KIMBERLITES, MAARS AND DIATREMES

Convened by the IAVCEI Commission on Explosive Volcanism.

For decades, there has been considerable debate about the relationship between kimberlites, maars, and diatremes. Evidence of the involvement of phreatic water in maars became quite strong by the early 1970's, but do kimberlites and diatremes all form through phreatic and phreatomagmatic explosions? Also, what about the common association of CO2-rich magmas with maars and diatremes? This symposium is proposed to provide the opportunity for workers in this area to debate the processes involved in these volcanoes, and the similarities and differences between them. We intend to allow time for general discussion of the issues at the end of each session.

Convenors:
Michael Ort, Northern Arizona University, Flagstaff, USA
Email: michael.ort@nau.edu Greg Valentine, Los Alamos National Laboratory, Los Alamos, New Mexico, USA Email: gav@lanl.gov

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