Commission on

Explosive Volcanism

The CEV Newsletter sponsored by IAVCEI
December 1999

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In this Newsletter..

Out of all the Y2K predictions of Armageddon, the one we looked forward to the most was the simultaneous explosive eruption (with appropriate evacuations, etc.) of all the world's active volcanoes at 24:00 GMT on 31 December 1999. Unfortunately this didn't happen (although the Eiffel Tower fireworks almost made up for it), but fortunately none of the other predictions held true either. Therefore we decided to go forward with this issue of the CEV Newsletter.

This issue is dedicated to reports on the two main CEV events at the IUGG General Assembly in Birmingham last summer. Both of these were field workshops, with one focused on explosive volcanism in part of the Aegean region, while the other workshop focused on deeply eroded calderas exposed in the UK. As you can see from the reports, both workshops were very productive. We heartily thank Mike Branney, Peter Kokelaar, Sharon Allen, and their support crews for the time and effort that they put into running these workshops. Both of us wish we could have been at both of them! The newsletter also contains some meeting announcements of interest and our annual membership directory.

We were both elected into office in January 1997, so our four-year term ends at the end of 2000. The meeting in Bali is the general meeting closest in time to the end of our terms, so we would like to have an election of new leaders then. Therefore we are initiating a search for two ~~suckers~~ successors. If you

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know anyone (including yourself) who is a potential ~~victim~~ nominee, please let us know. During our tenure, leading CEV has consisted of the following:

· Soliciting contributions for, editing, publishing, and distributing the semi-annual Newsletter.

· Maintenance of the CEV homepage (mainly by posting Newsletter issues there).

· Supporting, initiating and leading symposia on topics of interest to CEV

· Supporting and publicizing workshops led by CEV members.

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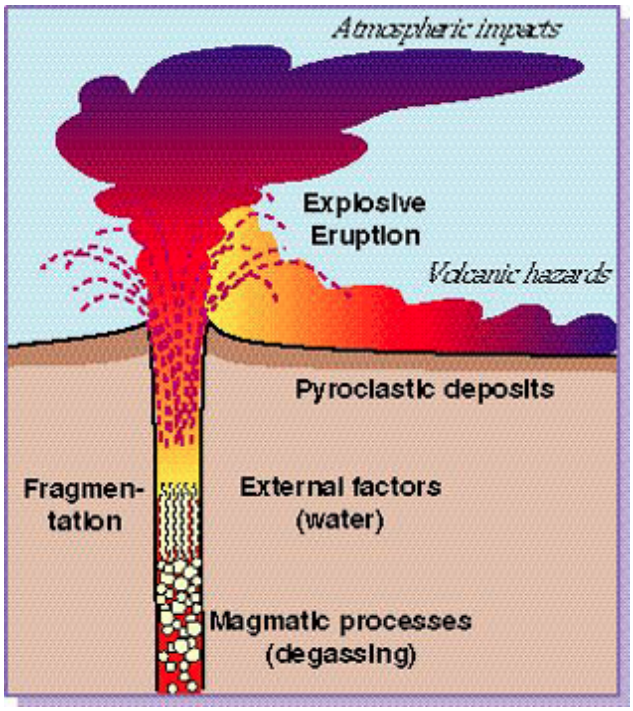
· Short annual reports to IAVCEI.

· Work towards launching a new Numerical Modeling Working Group.

We think there should be two co-leaders that share these responsibilities, and that they should be able to keep in good communication. We particularly think that the Newsletter is a key mechanism for keeping CEV members up to date and engaged, and that perhaps the most important of the above duties is regular publication of the Newsletter; in our experience commissions that do not have a regular vehicle of communication such as a newsletter tend to have little member involvement and to make little progress. This requires some infrastructure and inevitably some investment of the leaders' resources. In our case, we have been lucky to have the excellent assistance of Paula Geisik (and her predecessors) in laying out and distributing the Newsletter. Given all this, we hope that you will all consider either volunteering or nominating someone.

G. A. Valentine and

M. H. Ort, Co-Leaders



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Kos, Yali and Nisyros: CEV/IUGG 99 Birmingham Excursion C5, July 31-August 7, 1999

by Susanne Aarburg, Olivier Bachmann, Christian Bertagna, Caroline Choux, Lucia Gurioli and Margherita Polacci

For one week in the warm, sunny climate of the Mediterranean summer, the 18 participants of the Kos, Yali and Nisyros workshop gathered together on the island of Kos to see the spectacular exposures of the volcanic deposits from the eastern margin of the Hellenic arc. This field workshop focused mainly on the physical volcanology of the Kos Plateau Tuff (KPT), a voluminous (>60 km^3 DRE), ignimbrite-forming eruption that was emplaced as a consequence of late Quaternary paroxysmal explosive activity that was sourced in the area between Kos and Nisyros in the eastern Aegean Sea. In addition, day trips were also taken to the younger volcanic islands to look at rhyolite lava and submarine pumice breccias (Yali) and the Nisyros stratovolcano.

The main leader was Sharon Allen who was supported by a fairly large crew (Jocelyn McPhie, Georges Vougioukalakis, Joerg Keller, Johan Varekamp, and Ray Cas, who was unfortunately absent during this week in the field), whose various expertise were particularly instrumental in outlining the wide variety and geochemistry of volcanic deposits in the Kos-Nisyros area and their uses by ancient civilizations. All the participants are very grateful for the effort that Sharon and Georges put into organizing this trip to make it as beneficial and enjoyable as possible. We would also like to emphasize the benefits of the multidisciplinary and multicultural experiences that we had.

During the course of the workshop, several themes were developed that were discussed in the field and some continued into informal evening sessions chaired by Tim Druitt. These themes are outlined below together with our personal impressions and thoughts that evolved during this great experience.

Kos Plateau Tuff

The 161 ka KPT eruption can be subdivided in 6 major stratigraphic units: A (oldest), B, C, D, E and F (youngest) (Allen et al., 1999). Unit A and part of unit F are dominantly fallout deposits. The remainder are the products of pyroclastic density currents that were either relatively fine grained, internally stratified and locally confined(units B, C and part of F), or massive, relatively coarse, widespread ignimbrites (units D and E).

1. Location of the source:

The inferred center for the source is situated 10 km south of Kos, close to Yali in the middle of a caldera estimated to be 6-11 km in diameter. This area is submarine and detailed bathymetry in the area around Yali is obscured by volcanism that post-dates the KPT. The large volume of andesitic lithic clasts within the KPT that are interpreted to be vent-derived suggests that a pre-KPT andesitic edifice was positioned close to the vent(s). Several questions were raised: (1) Can variations in the lithic clast typesdistinguish whether this venting was constrained to a central point, a ring fracture (e.g. Hildreth and Mahood, 1986) or fissure? (2) How is the 15-20 km wide volcano-tectonic depression between Kos and Nisyros related to the Kos caldera? Is this depression the caldera?

2. Effect of external water on the eruption, transport and deposition of the KPT:

(a) At the vent: The initial and possibly final stages of the eruption were phreatomagmatic, involving a relatively large volume of water that had unrestricted access to the vent(s). However, during the most intense phases of the eruption when ignimbrites were produced, the activity was dominantly dry-explosive activity. It was proposed that the vent was located in a submarine environment with variations in eruption rate controlling the magma-water interaction. Questions: Did the vent position change and the pre-KPT andesitic cone provide a barrier, inhibiting magma:water interaction? Are the gradational boundaries between

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There was much discussion on the terminology, trigger and emplacement mechanisms for this mixed layer and

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unit B (phreatomagmatic) and C (transitional phreatomagmatic/dry explosive) due to sustained eruption conditions?

(b) During transport: The basal lithic breccia of unit E (Ebx) (Figure 1) displays extremely coarse lithic clasts, some of which are certainly vent-derived, that are up to several meters in diameter on Kos. In addition, vent-derived lithic clasts are several tens of centimeters in diameter on the island of Tilos, which is separated from the source by >20 km of sea water. This phenomena was attributed to the high momentum of the transport system possibly as a result of lateral explosions at source. Due to the size and density variations between the large dense lithic clasts and smaller, highly vesicular pumiceous pyroclasts, separation into a lithic-rich front of the current probably occurred at source. There were many debates on the possible eruption and transport mechanisms for Ebx. Questions: Does this indicate extremely turbulent conditions if such clasts were transported across water, or was some other mechanism involved?

(c) During deposition: Along the coast of north

Figure 1: Basal lithic breccia (above dashed line) in the unit E (Ebx) of the Kos Plateau Tuff.

whether wet or dry liquified sediments were involved.

3. Sedimentological features of the KPT pyroclastic deposits and their relationships to eruption conditions:

(a) The vitric ash unit, A, shows general characteristics of a phreatoplinian fall deposit but comprises low angle cross-stratification due to deposition during windy conditions or emplacement from dilute gravity currents.

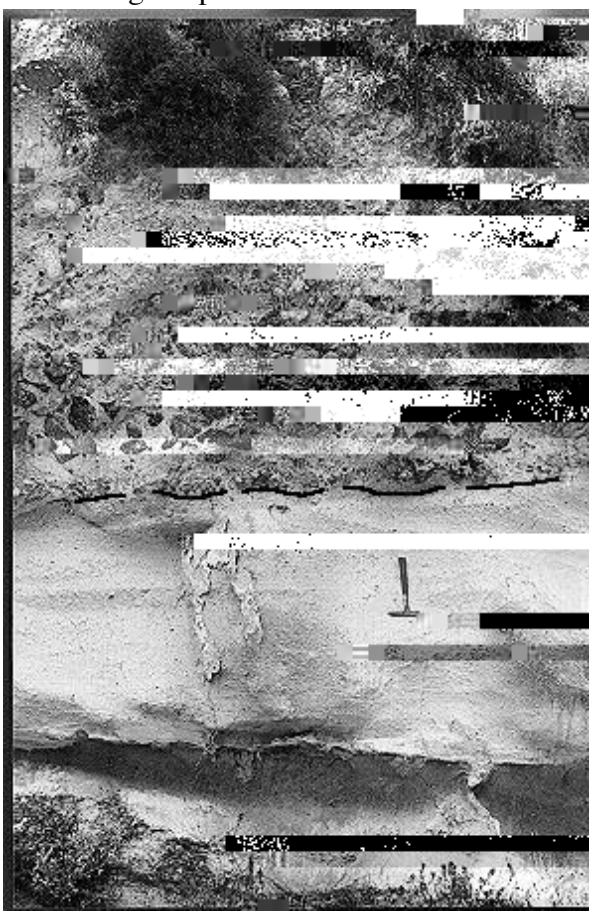
(b) The internally stratified pyroclastic density current deposits (units B, C and subunit Fs) do not resemble either surge or conventional ignimbrites.

(c) Topography seemed to have had a strong control on the distribution of the unit D ignimbrites compared to those in the overlying unit E. In addition, unit D is finer grained and less voluminous than unit E. Furthermore, the sizes of the vent-derived lithic clasts within unit D appear to increase in size toward the top, with the greatest abundance and sizes of these clasts occurring within the base of unit E. Unit E corresponds to a dramatic increase in eruption intensity inferred to correspond with major caldera collapse.

4. Lateral facies variations within the KPT co-ignimbrite lithic breccias:

(a) Coarse basal co-ignimbrite lithic breccia of units D and E are highly laterally variable and often do not match the size of the lithic clasts within the overlying pumiceous facies. In addition, intra-ignimbrite breccias and

central Kos, the basal part of unit E has mixed and mingled with unconsolidated sediment resembling the products of a debris avalanche.



lithic clast swarms occur within ignimbrites. Question: Does this suggest progressive aggradation of an unsteady current and deposition during fluctuating eruption intensity?

(b) A double lithic breccia (10 to 30 cm thick), which is separated by a thin (10-15 cm) layer of lithic-poor ignimbrite, occurs at the base of ignimbrite Dm in

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some places. Question : Is the lower, relatively steeply-dipping bedded lithic breccia the result of syn- and immediately post-depositional slumping ?

5. Fragmentation:

(a) Based on observations of lithic clast populations, the fragmentation region seems to deepen with time from unit A to unit E, as deep-seated basement granitoid clasts appear only in unit E. Question: Is this a general process during the eruption, where widening of the vent inhibits the rise in fragmentation level?

(b) The presence of different populations of pumice clasts (white rhyolitic, gray andesitic and banded) that are characterized by highly variable volcanic textures (vesicularities, vesicle sizes and shapes, vesicle wall thickness, crystal sizes and shapes). Question: Do these variations record the development of conduit regions marked by a non-homogeneous rheological behavior (e.g. Papale, 1999).

6. Petrogenesis of large silicic magma bodies in the upper crust:

(a) The KPT magma genesis may be the result of remelting of a granitic protholith at shallow depth upon mafic input (Keller, 1969). There are granitoid fragments in unit E, which Kalymnos are generally finer grained, particularly unit D. However, large vent-derived lithic clasts (Figure 2) remained within unit E. A high abundance of well vesiculated "frothy" pumice occurred within unit E. These clasts have lower densities than the pumice clasts within unit E on Kos. Large boulders of Kalymnos pre-eruptive basement were scraped and transported down into the valley by the transport system that deposited unit E. The basal part of the ignimbrites comprise low-angle cross-stratified finer layers and inverse grading. Questions: Do these layers resemble traction carpets and did this stratification result from topographically-induced, highly turbulent conditions? The inverse grading at the base of the ignimbrite is probably the result of kinetic sieving and shearing. Question: Did the pyroclastic flows traverse a ~400 m-high ridge to reach the narrow-mouth Vathi valley?

8. The knowledge of Joerg Keller and Georges Vougioukalakis of other volcanic deposits on Kos allowed us to stop at an archaeological quarry in a

have partially melted textures and are chemically indistinguishable from the white KPT pumice.

This area was seen as a high contender for further work. High precision $^{40}Ar/^{39}Ar$ dating on biotite and alkali feldspars in pumice and holocrystalline xenoliths is currently underway at the University of Geneva in order to try to distinguish between the age of crystallization of the pluton and the age of the KPT eruption.

7. Behavior of pyroclastic flows in distal areas (>30 km from inferred source):

(a) On the day trip to the beautiful Greek island of Kalymnos, 15 km north of Kos, we were welcomed by the Mayor and treated to the generous, hospitable and friendly nature of the local people. The more distal KPT ignimbrites on

Figure 2: Large vent-derived lithic clast (~40 cm in diameter) found in the KPT on Kalymnos, more than 30 kilometers away from the inferred source.

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Miocene ignimbrite and view the Quaternary Kefalos pyroclastic series.

Yali pumice breccia and lava

Further local hospitality was shown by the quarry company "lava" which provided transport and lunch for our day on the small islet of Yali.

(a) Here we walked up a thick succession of pumice interpreted to be derived from submarine suspension settling and syn-eruptive, resedimented grain flows. Evidence for interaction of the hot pumice clasts with water, include tiny normal joints and quenched surfaces. The pumice clasts comprise different textural characteristics (vesicularities, vesicle sizes and shapes, crystal content) and chemical composition (SiO_2 range: 63.2-77.2 wt%). The chronology of the various layers that overlie the pumice breccia constrain its subaqueous deposition. Joerg Keller pointed out the neolithic remains derived from obsidian on Yali and Milos. Question: Were the pumice clasts derived from effusion or pyroclastic processes?

(b) Jocelyn McPhie showed us the various textural features of rhyolite lava on the northern part of the island which included flow banding, spherulites, lithophysae, perlite, pumiceous carapace and autobreccia.

Nisyros stratovolcano

The last day of the workshop was highlighted by a trip to Nisyros led by Johan Varekamp, Joerg Keller and Georges Vougioukalakis who instructed of the pyroclastic deposits of the Upper and Lower Pumice, which include fallout, surge and flow beds during an eruption influenced by hydrothermal fluids. In the centre of the island is a multi-stage summit caldera (3-4 km wide; Figure 3), partly filled up by late Quaternary lava domes, that is located at the intersection of two orthogonal active tectonic faults, a feature observed in Santorini (Druitt et al., 1989) as well as in other older volcanic complexes such as Snowdon in North Wales (Kokelaar, 1992) and Glen Coe in Scotland (Moore and Kokelaar, 1998). Each new eruptive episode comprises mafic inclusions, which have a distinct chemical signature and represent the influx of a chemically distinct mafic magma. Hence, each eruptive cycle is unrelated. This probably records a complex plumbing system with absence of long-lived magma storage beneath the volcano.

Figure 3: View of a phreatic crater inside the caldera on Nisyros, as seen from the village of Nikia, on the southern side caldera rim.

us on the various volcanic, petrological and geothermal facies of the Nisyros volcano. Nisyros is an Upper Quaternary complex stratovolcano from which the last activity (phreatic) occurred at the end of the past century. There have been four main stages of evolution: (1) an early submarine stage (pre-KPT), followed by uplift and erosion, (2) a major cone-building stage forming a complex andesitc stratovolcano, (3) plinian eruptions and viscous lava extrusions with associated multiple caldera collapse, and (4) infill of the caldera with large viscous domes (Francalanci et al. 1995). We viewed the volcanology

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Evening Discussions

The first evening discussion session focused mostly on pyroclastic density currents, with particular emphasis on flowage over water and highly turbulent flows. Reviews of current ideas and theoretical advances were outlined by Tim Druitt (Clermont-Ferrand, France). Tad Ui (Hokkaido, Japan) described the ~7000 BP Koya pyroclastic flow deposit (Japan) which prior to the deposition on Kyushu crossed tens of kilometers of sea water. Caroline Choux (Clermont-Ferrand, France) discussed density-driven particulate flow experiments, which showed strong internal segregation of particles according to densities differences. Finally a comprehensive field study on the 79 AD Vesuvius eruption was presented by Lucia Gurioli (Pisa, Italy).

The second evening discussion session focused mainly on fragmentation processes, fragmentation depth and origin of lithic fragments. Margherita Polacci (Pisa, Italy) described the textural character istics of the climactic phase of the 1991 Pinatubo eruption and discussed magma ascent dynamics. Joop Varekamp (Middleton, USA) also presented numerical calculations bearing on the volumes and provenance of lithic fragments.

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Figure 4: The group ready to return to Kos after a good pumice climb and a great meal on Yali with the mining company "lava". Back: Vince Neal, Caroline Choux, Johan Varekamp, Sharon Allen, Tim Druitt, Georges Vougioukalakis. Centre: Lucia Gurioli, Christian Bertagna, Margherita Polacci. Front: Susanne Aarburg, Rodney Allen, Ursula Robert, Tad Ui, Joerg Keller, Jocelyn McPhie, Olivier Bachmann.

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A FIELD WORKSHOP REPORT: IAVCEI-CEV/IUGG FIELD WORKSHOP

JULY 7 18, 1999

INSIDE SILICIC CALDERAS

by Marty Godchaux and Bill Bonnichsen

LEADERS: Peter Kokelaar, Department of Earth Sciences, University of Liverpool

Michael Branney, Geology Department, University of Leicester

PARTICIPANTS (BY COUNTRY):

United Kingdom: Tiffany Barry, Richard Brown, Sue Loughlin, Andy Saunders, Helen Morgan

Italy: Valerio Acocella, Danilo Palladino, Laura Pioli, Roberto Sulpizio

New Zealand/Australia: Jim Cole, Dave Milner, Karl Spinks, Stuart Brown

United States: Bill Bonnichsen, Jon Davidson, Marty Godchaux, Sheila Seaman,

Shan deSilva, Richard Waitt, Mike Williams

Canada: Bob Anderson, Ben Kennedy

Switzerland: Olivier Bachmann

France: Oliver Roche

Sweden: Annika Wasstrom

Germany: Jan Lindsay

* *

This workshop almost defies superlatives. It was a superb professional experience, a movable feast of international camaraderie, a series of stunningly beautiful landscapes, a demonstration of what great science can be done by dedicated field geologists in well-exposed terrain, a tour of three very different countries (Wales, England, Scotland), and a pretty brutal way to get back into shape for those of us who had gotten out. The leaders expended nearly as much energy as did the original (very large) eruptions in their efforts to ensure that each participant had the equivalent of a privately guided field trip. They patiently repeated outcrop spiels for the slower climbers (sometimes several times), guided the group unerringly to the best photo-ops, and taught us Welsh, Gaelic and Britspeak (more on that below) in their spare time. They also elicited contributions from all the participants, both in

the field and in evening sessions, so it was a true participatory experience for all. Workshop Secretary Helen Morgan, the group's guardian angel, had worked hard to set up all the arrangements, and the logistics, accommodations and meals were absolutely flawless. It would require a longer document than this one to acknowledge all her contributions, but she had the group's heartfelt thanks and admiration. Also deserving of thanks were the skillful (and daring) van drivers, Tiffany Barry, Richard Brown, and Andy Saunders. Since the fee for the workshop was quite low, and the information content and enjoyability quotient were quite high, it was a terrific value for the pound/lira/dollar/franc/kroner/deutschmark. The guidebook deserves mention here. Beautifully written and illustrated, with many humorous asides, it is a treasure in its own right; these writers find they are appreciating it even more upon re-reading it, months after the trip, than they had initially. To round out a marvelous experience, each and every participant came to the workshop with fascinating insights gleaned from field areas in volcanic systems of various ages in several other parts of the world, augmented and informed by laboratory investigations and computer simulations. Not to mention rollicking enthusiasm, prodigious appetites for the local food and brew, and a plethora of field stories of dubious veracity, most of which cannot be repeated here. Discussions, guided but not dominated by the leaders, ranged

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(Godchaux and Bonnichsen continued from page 8)

from eruption mechanisms to sedimentology to details of near-surface caldera structure to deep crustal structure and plate tectonics, and occasionally to the perceived intelligence and delicate hygiene of the ubiquitous sheep All field trips can be placed somewhere along a continuum from rolling poster sessions at the sedentary end to death marches at the physically challenging go-see-the-rocks grade ignimbrite, the Pitts Head Tuff, emplaced upon "sloppy" wet sediments. Intriguing features such as complex brecciation patterns and a near-basal nodular zone generated enthusiastic discussion. An overlying nonwelded ignimbrite, with some anastomosing small-scale basalt intrusions into mesobreccia zones within it, attracted the interest of many. Those of us who work with either young undeformed ignimbrites or old intensely deformed ones especially appreciated the opportunity to see one that had suffered

end; this one was most emphatically not a rolling poster session. In fact, it was downright refreshing to spend ten days in some of the world's most spectacular volcanic real estate and never once see a spider diagram or hear more than casual mention of an isotope .

Days 1 3 WALES

Our introduction to the Snowdon Caldera and related volcanics on the first full day in the field began with a splendid overview lecture by Peter, employing the powerful narrative skills of a natural-born Welsh storyteller and the small white board and red and green markers that would become very familiar sights in the days to come. The vantage point for the lecture provided a view into the caldera, with fog-shrouded Snowdon Peak and other high points arrayed along the northern margin. As Peter talked and sketched, the misty grey cloud slowly dissipated, providing a natural metaphor for the (enjoyed?) just enough tectonic deformation to produce a distinct axial-planar cleavage, but not enough to wipe out primary textures and structures.

The second day of the Workshop was devoted to close examination of rocks on the northeast flank of Snowdon Peak, near the northern margin of the caldera. Of particular interest was the Bedded Pyroclastic Formation, a dominantly basaltic and sedimentary package between two thick rhyolitic tuffs. Glacial erosion has produced magnificent exposures of this complex unit, enabling an exquisitely detailed reconstruction of the alternating resurgent uplift and rift-related subsidence, the waxing and waning of volcanism, and the shifting sources of sediment. Walking up to Ordovician sea stacks cut from a lava flow that had flowed out onto a beach platform seemed like a trip in a time machine. Aficionados of sedimentary structures found plenty to photograph and to discuss on this traverse, from liquefaction and loading features to interesting volcanic breccias to mega-ripples to foreset bedding to a distinctive limestone marker horizon. The leaders did a superb job of presenting the evidence, and established an airtight (even beer-tight!) case for their interpretations, triggering much useful discussion of similar features and processes in volcanic systems elsewhere.

The aforementioned glacial erosion produced steep and debris-laden slopes that led to practical lessons in Britspeak. "It's just a bit of a grunt up to" means we will be going up an 80-degree slope for what may seem like several hours. "We'll just bimble down

lifting of our own "fogs," and the folded, faulted, glacially-sculpted modern landscape gradually gave way to a compelling vision of the Ordovician one. Volcanism migrated within a broad basin from what is now the southwestern part of the region toward the present-day northeast over a period of perhaps 2-4 million years, and SW-NE trending grabens formed and shifted back and forth, orchestrating a complex interplay between deep and surficial processes. Rhyolitic and basaltic magmas alternately gained access to conduits, resulting in a complex section of tuffs, lavas and volcaniclastic sediments. Discussion was spirited, touching upon caldera-substrate relationships, magma genesis, resurgence or lack thereof, criteria for determining subaerial vs. subaqueous deposition and welding of tuffs, Pleistocene evolution of the landscape, and how to spell Welsh names (one unit, which sounded like where-are-thee, turned out to be yr arddu). The rest of the first day was devoted to close examination of a very high-

(Godchaux and Bonnichsen continued on page 10)

(Godchaux and Bonnichsen continued from page 9)

the back end of the sheep" accompanied by an arm-wave toward a hillside containing dozens of brownish crags and hundreds of sheep means that to" means we will be in free fall most of the way (the guidebook, in fact, notes that "Fall velocities here tend towards terminal Please take care here!"). "On that brownish crag, just above

Here, as in Wales, the leaders demonstrated an awesome knowledge of the stratigraphic, structural, petrographic, tectonic and even

the feature in question is up there somewhere. It is considered poor form to ask which crag and/or which sheep.

The third day's excursion provided another look at the high-grade Pitts Head Tuff of Day 1, this time in a more distal (about 20 km NE of source) setting, where it had entered the sea and displaced the shoreline. Spectacular rheomorphic folds and sliding features triggered discussion of whether or not we could tell if these were all produced during hot-state sliding, which brought us to the emotionally-charged topic of submarine welding. While no actual fisticuffs broke out, arguments were animated. One possible conclusion is that subaqueous welding, like haggis, may be an acquired taste. Restraint here was rewarded with a brisk hike over a saddle (great photo-op of the Idwal Syncline!) to see the outflow facies of the first rhyolitic ignimbrite erupted out of the Snowdon caldera. Like so many things in Wales, this unit was diverse, attention-getting and enigmatic. The nature of the massive breccias near the base and the breccia lenses higher up, the subtle but extensive stratification in the main body of the ignimbrite, the "diagenetic-eutaxitic foliation," and the fine-grained porcellaneous layer at the top all generated much discussion. Only the prospect of beer and pizza, coupled with an awareness of the hours of driving time between North Wales and the English Lake District, pulled us away from these outcrops before sunset.

Days 4 - 7 ENGLAND

The fourth day dawned bright and clear in the drop-dead-gorgeous English Lake District, flooding the soul with the philosophical parameters of the volcanic system in all their myriad details. Mike's overview of the Scafell Caldera was a tour-de-force, highlighting similarities and differences with the Snowdon Caldera and providing an excellent background for the close-up field experiences. Principal differences between Scafell and Snowdon included Scafell's lesser intensity of post-volcanic (Devonian) folding and regional metamorphism, more chaotic pattern of piecemeal caldera subsidence, more exposure of caldera-fill facies and less exposure of outflow sheets, more complex caldera-fill stratigraphy, prominence of andesitic compositions early in the eruption, and apparent alternation of phreatomagmatic eruptions with very high-grade magmatic ones.

The fourth day's excursion provided an opportunity to walk up through precaldera rocks, mostly clastic rocks with interbedded andesitic lava flows and/or peperitic andesite sills, to arrive at the base of the andesitic Whorneyside Ignimbrite. This massive unit, here more than 10 km away from its source, appeared to be subaerially deposited, with recognizable fiamme and small lithic clasts throughout. Mike led us up through a transition zone into the Whorneyside phreatoplinian tuff, a thick and very fine-grained deposit with fine-scale planar lamination and spectacular soft-state deformation. Much time was spent exploring and photographing the beautifully preserved primary features of the tuff, as well as its nearly ubiquitous soft-state deformation features. Discussion of the real criteria for identifying 'phreatoplinian' deposits, and of the conditions and processes promoting

kind of inspiration that must have influenced the famed poets of the region. Despite broadly similar geology (Pleistocene glaciers sculpted Ordovician volcanic rocks) and similar hillslopes, summit elevations and sheep, the ambience here is one of a light, civilized and gentle wilderness, as compared to the brooding majesty of the Welsh mountains. One of the many fringe benefits of this Workshop is an enhanced feeling for the natural wellsprings of the poetry of both regions.

soft-state faulting (and doubtless many other topics) buzzed back and forth within small groups.

Above the Whorneyside, an abrupt change from andesitic to dominantly rhyolitic compositions took place, signalled first by the appearance of a flinty-looking white rhyolitic accretionary-lapilli-bearing tuff. It was about at this point that we began hearing the phrase "Not bad, for the Ordovician" Translation: This is possibly the best example you'll ever see anywhere of this particular phenomenon, but modesty forbids our putting it that way Above

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the first rhyolitic phreatomagmatic tuff, rhyolitic ignimbrites of increasingly higher grade, punctuated at intervals by thin phreatomagmatic layers, completed the traverse for the day. Although layers higher up in the section looked tempting, the siren call of the waiting pubs became louder as the sun sank lower in the sky, and leaders and participants agreed to save the rest of the Central Fells' wonders for the next three days.

The fifth day of the trip involved an 800-meter ascent up the side of a large scramblingbeware the treacherous steep grass and loose rocks remember, the locality has not been named frivolously!" To this the present authors would add, "Try not to kneel or sit on the wet grass, unless you really want to go around for the rest of the day smelling like sheepsh_t" Wimpy grousing notwithstanding, it was a spectacular section to which this climb provided access all the previously inspected ignimbrites (some containing primary volcanic garnet phenocrysts, euhedral and beautiful, winking wickedly and seductively to beckon the

and picturesque glacial valley. Parts of the climb were indescribably steep like climbing a wall of wet grass but the exposures of syn-eruptive faults with draped and ponded ignimbrite adjacent to them made the effort worthwhile. Evidence for multiple episodes of movement, with reversals of offset, along some of the intracaldera faults was dramatic. A bit higher up in the section were exposures of tuffs so high-grade and so lava-like that they might even have been lavas Possible reasons for the upward increase in grade in this Bad Step Tuff were bandied about. Were these tuffs erupted from a more proximal source than the lower-grade ones below, was hotter basaltic magma injected into the base of the silicic chamber (a basaltic phreatomagmatic tuff immediately overlies the Bad Step Tuff), or did increasingly catastrophic caldera subsidence trigger the eruption of lower, hotter columns at a higher mass flux? Brecciation of ignimbrites was another phenomenon that seemed to become more widespread and pervasive as we went up-section. A goodly amount of beer was wagered over the precise origin of this or that lens, with generally no final resolution but certainly no implication that such ambiguity should in any way inhibit beer consumption.

The sixth day, misty with some rain, took us to a sort of Ordovician 'ground zero,' across the valley from the starting point of the previous day's traverse, where dramatic differential subsidence of adjacent fault blocks and thick ponding of high-grade ignimbrites testified to the piecemeal nature of the climactic phases of the Scafell eruption(s). Even the stout-hearted faint-hearted onward and upward!), plus phreatomagmatic tuffs, breccias, and, near the top, caldera-lake sediments of varied character. Since a section this rich in enigma and this fraught with global-volcanic implications might well prove to be an emotional and intellectual overload for dazzled participants, Mike wisely (some said uncharacteristically) decreed that a soothing afternoon of art galleries and shopping was in order. And indeed the Kirkstone Galleries and the shops in Ambleside did provide a balm to the fevered brain. "Who journey thither {Grave Gill} find themselves alone, With a few sheep, with rock and stonesWho comes not hither {Kirkstone} ne'er shall know, How beautiful the world below" How honey cakes bedeck'd with nuts, Soothe aching knees, and feet, and butts(with apologies to William Wordsworth). A perfect day, with one final treat in store: After dinner, Valerio Acocella, Oliver Roche and Ben Kennedy presented thoughtful discussions of controls on the structural evolution of calderas, with information gleaned from sophisticated modelling experiments.

The seventh day brought us around to Sour Milk Gill on the north side of the Scafell Caldera, nearer to the source of the Whorneyside eruptions than we had been previously, where we could examine the subaqueously deposited/reworked phases of the Whorneyside phreatoplinian tuff, and its interactions with andesitic sills intruded between it and the underlying Whorneyside Ignimbrite. All 160 meters of the phreatomagmatic tuff have been logged bed-by-bed and divided into six principal lithofacies, a great labor of love which allows an

among us noted with some disquietude the description of the climb up Grave Gill: "The excursion involves a shortsteep, walk, with a little desperate (ed.) [word 'desperate' is crossed out] unparalleled birds-eye view of the interplay of volcanic, sedimentary, intrusive and tectonic processes in this brief

(Godchaux and Bonnichsen continued on page 12)

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slice of Ordovician time. For those fond of real-time eruption narratives it seemed not too much of a stretch to write in our field notes, "It was around 3:45 on a rainy Thursday afternoon in Middle Caradoc time when partial collapse of the southern flank of Mt. Whorneyside allowed ingress of standing water to the vent, causing a vast spreading phreatoplinian cloud to darken skies over much of the British Empire" Well, the guidebook does make passing note of an arthropod trail in the tuff, commenting that "the creature probably was lonely and miserable;" perhaps the purple prose above can be attributed to the arthropod's field notes. Like Wordsworth's poetry, this section could be visited again and again, each time revealing new insights, but the time had come to pack up and move on to the third area of the Workshop.

Days 8 10 SCOTLAND

The eighth day of the Workshop was spent driving, at least by the van drivers. For many participants it would be better described as a day spent dozing. Those who stayed awake were

southern Sierra Madre Occidental, Mexico).

On the ninth day of the excursion, our good luck with the weather finally ran out; it rained off and on all day, making for slippery climbing and tricky stream crossings. The rocks, however, were spectacular. The peperitic tops of the andesite sills displayed a plethora of intricate textural variations multiple brecciations, apophyses of andesite into overlying sediments, vesiculation of fine-grained sediment adjacent to the andesite, and other features competed for the remaining frames of film that many of us were rationing at this point in the trip. A panoramic view of the locally overturned caldera margin was also photogenic, despite the increasing rain and fog. A long(ish), steep(ish), miserable(ish) scramble brought us up to the basal contact of the King's Tuff, the product of the phreatomagmatic opening blasts of Glencoe Caldera volcanism. This distal exposure, about 7-8 km from the putative source, is fine-grained and has recognizable accretionary lapilli. Above the tuff were exposures of thick and problematic "lava-like ignimbrites," about which

rewarded by good scenery and some interesting out-the-window geology in the Midland Valley and the Highlands of Scotland. Arriving at Glencoe a bit too late in the afternoon to start out on a field excursion, we were treated to an overview of the Glencoe Caldera by Peter. After being introduced (brainwashed?) to piecemeal subsidence at Snowdon and Scafell, we were not overly surprised to learn that Glencoe, long the literature model of a simple ring-piston caldera, wasn't. In keeping with the legendary thriftiness of the Scots, here we got not only a persistent, complex NW-SE master graben but also several cross-grabens, three tuff cones, five thick ignimbrites, numerous breccias, and a thick sequence of andesite sills with magnificent peperitic margins. No one mentioned a partridge in a pear tree, but its functional equivalent may have been the Dalradian metamorphic basement, which seemed to be at the bottom of everything. At 421 m.y., Glencoe is the youngest of the three calderas and the only one that escaped later tectonic deformation and metamorphism. Brief evening presentations were given by Bill Bonnichsen and Marty Godchaux (Tertiary Snake River Plain, Idaho, USA, volcanism) and Richard Waitt (Tertiary ignimbrites of the there was much discussion but little consensus a perfect illustration of the difficulties in interpreting the precise mode of origin of such rocks in caldera systems everywhere. Above these lava-like units were exposures of the slightly lower-grade ignimbrite of the caldera-fill sequence. A point worth emphasizing here is that the very high-grade ignimbrites appeared early in the sequence at Glencoe, in contrast to similar rocks at Scafell, which appeared after a large volume of somewhat lower-grade ignimbrites had been erupted. Above the final ignimbrites was a unit of thick and diverse breccias. A long cold descent was followed by hot baths, dinner and beer (order of importance may vary from participant to participant, but for some of us a long hot bath was a necessary prelude to being able to walk again). After dinner, we enjoyed a fine presentation on the Taupo Zone by Jim Cole and the New Zealand group, and an interesting talk on the San Juans by Olivier Bachman.

One might have read literary descriptions of howling winds and driving sheets of rain in novels set in Scotland and thought them florid and exaggerated. The morning of the tenth day, however, prompted an appreciation of the meteorological

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(Godchaux and Bonnichsen continued from page 12)

accuracy of such descriptions. Even Peter agreed (reluctantly) that it was probably not a good day to ride a ski lift, hike down a mountain, and cross a raging river. Thanks to the generosity of the van drivers we got a morning shopping trip in the lovely town of Fort William instead. No matter what one's attitude toward shopping might be, it definitely beats being dashed to death on the rocks under the ski lift and/or drowning in the river. By early afternoon the storm had largely passed, and we were able to go back to the field, where we got a close look at the King's Fan deposits, which record the earliest cross-graben formation in the incipient Glencoe Caldera, and the overlying proximal (tuff-cone) facies of the King's Tuff. Another useful bit of Britspeak was employed here. The phrase "and dumpty-dump" can mean, variously: 1) There's another five hundred meters of this same stuff above us, 2) The sum total of all geologic processes that have affected this area since the Ordovician, or 3) I forgot what else I was going to say.

Back at the hotel, Shan deSilva gave a thoughtful and enlightening talk on the Central Andes, which elicited much discussion about the fundamentals of crustal structure, magma genesis and ascent/storage/eruption processes. Danilo Palladino presented some thoughts and caveats about ways we might recognize true phreatoplinian deposits when they are incompletely preserved in the geologic record. A wonderful farewell banquet was followed by more discussions, reminiscences, and a heartfelt thanks from the whole group to Peter and Mike (who can now say they've been

there, done that, got the T-shirt), for a marvelous ten days, for all their hard work, enthusiasm and seemingly endless willingness to suffer fools gladly.

This workshop has a lot of "staying power." The new insights and perspectives gained from it will surely impact positively on our collective work for many years to come. In conclusion, we can only say that if you are interested in volcanism and/or sedimentation and/or tectonism and/or sheep, and this workshop is offered again, do anything you have to do to be on it. Just try to get into shape before the trip starts.

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Exploring Volcanoes:

Utilization of their resources

and

Mitigation of their hazards.

** Topics of symposium :*

- utilization of energy and other volcanic resources

- volcanogenic sediments

- volcano geophysics

- volcano seismology

- volcanic gases

- magmatic processes

- hazard mitigation

- physical volcanology

- mineralization related to magmatism

- structure of volcanic island arcs

- crater lakes

- additional session: surtseyan volcanism

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http://www.vsi.dpe.go.id/iavcei.html

Auckland, New Zealand

February 12th 16th, 2001

An international meeting to bring together volcanologists, sociologists, psychologists, emergency managers, economists and city planners to re-evaluate volcanic crises preparedness and management in cities and densely populated areas.

Organised by the Institute of Geological & Nuclear Sciences (IGNS) Auckland Regional Council (ARC), Massey University, The University of Auckland, and International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI)

This meeting will be held from Monday, February 12th to Wednesday February 14th 2001, at the Sky City Conference Centre in Auckland, New Zealand. Following the meeting, 2 days of field trips (on Thursday 15th and Friday 16th of February 2001) are scheduled.

TOPICS:

Education

Emergency Management / Crisis Management

Hazard and Risk Assessment

Volcano Monitoring

Social Impacts / Public Health

Economic Impacts and Insurance

Physical / Engineering Lifeline Impacts

Volcanic Processes

The registration fee is NZ$400. Numbers will be limited to 600 participants.

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To receive more information and the second circular mail, fax or e-mail:

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Montagne Pelée 1902 - 2002:

Explosive volcanism above subduction zones.

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A workshop will be organised in 2002 by the Institut de Physique du Globe de Paris sponsored by IAVCEI, the territorial authorities of French Antilles, the Institut National des Sciences de l'Univers (CNRS), to commemorate the 1902 eruption of Montagne Pelée. This workshop will be located in Martinique (French Antilles) the week before or after May 8, 2002. It will be preceded and followed by field trips.

Tentative Topics:

1. Eruption regimes

· lava domes : growth and explosivity

· Plinian eruptions

· transport and deposition of pyroclastic flows

· flank failure of volcanoes

· impact of fluids on eruption regimes

(Physical modelling will be widely developed in these topics).

2. Volcanism and tectonics

· tectonics and seismicity in subduction zones

· relationship between tectonics and volcanism

3. Genesis and evolution of calc-alkaline magmas.

· sources (mantle, subducted crust, sediments)

· melting and differentiation, contamination, magma mixing

· impact of fluids

4. Man facing volcanoes, crisis management, and case histories.

· socio-economic aspects of eruptions

· volcanic plumes and hazards to aircrafts (modelling and case histories)

5. Surveillance of volcanoes and eruption forecasting

· surveillance monitoring : present and future

· geological, geophysical and geochemical precursors to volcanic eruptions

· eruptive history of volcanic eruptions

· eruptive scenarios

To receive the first announcement, you must express your interest and

send your co-ordinates to: Obs.volcanologiques@ipgp.jussieu.fr

Due to space limitations, the workshop will be limited to about 150 people.

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