
Rounded, normally graded pumice in shoreface deposits formed from Lake Taupo. Large pumice clasts take longer to initially saturate with water than small ones, but they have higher settling velocities once saturation is achieved. Redeposition of saturated clasts produced this exceptionally normal bed (see newsletter).

COMMISSION ON VOLCANOGENIC SEDIMENTS

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INTRODUCTION

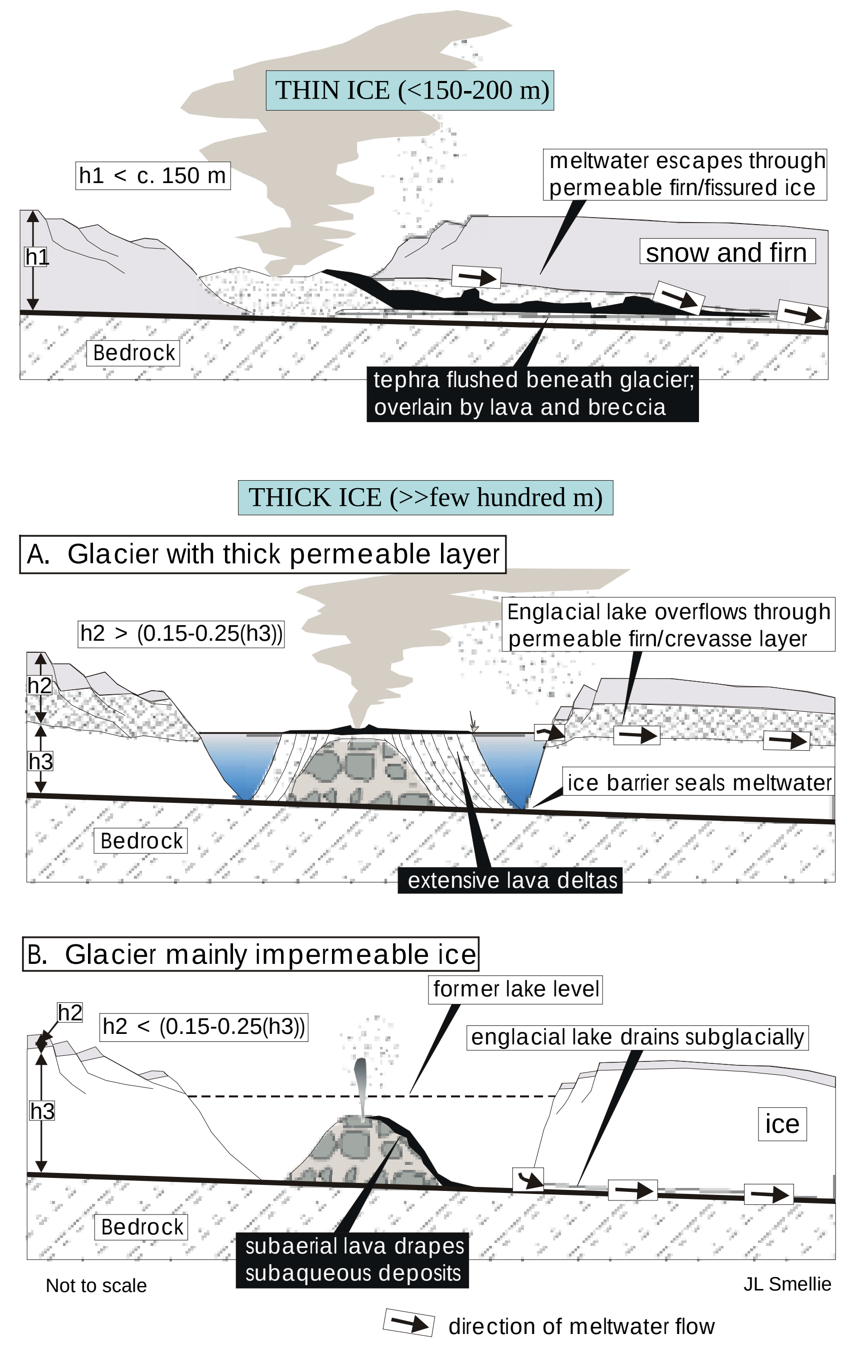
In this issue:

It's time (or a bit past) for another issue of the biannual CVS newsletter. This issue features a subglacial item related to the first of two upcoming gatherings in August of this year. Both meetings deal with hydrovolcanic eruptions, water, and tephra, both deposited and re-deposited. Early August brings the Ice-Volcano interactions meeting in Iceland, and just after (the field trips overlap a bit) is the First International Maar Conference, to be held in Daun, Eifel region, Germany (more info below). The focus of the Ice-Volcano meeting is subglacial eruptions on earth and other planets (see article below). The Maar conference addresses the whole range of processes that characterize maars, from their formation during explosive groundwater-driven eruptions, through subsequent occupation by lakes and the nature of sedimentation and the fossil formed within, to their role as hydrological structures today and the geophysical methods used to assess them.

Other meetings also offer treats for the volcaniclasticist. Two field trips to beautifully exposed volcaniclastic successions are being run, by Woody Brooks and colleagues, as part of the National Association of Geoscience Teachers far-west section meeting in Blairsden, California (see ad later in newsletter). Also, the run-up to the IAS regional meeting in Dublin continues; don't wait too late.

Terrestrial subglacial eruptions - a personal perspective

By John Smellie, British Antarctic Survey (JLSM@bas.ac.uk)



Cartoon showing the effects of varying glacier thickness and structure on hydrology and sequence of lithofacies during subglacial eruptions.

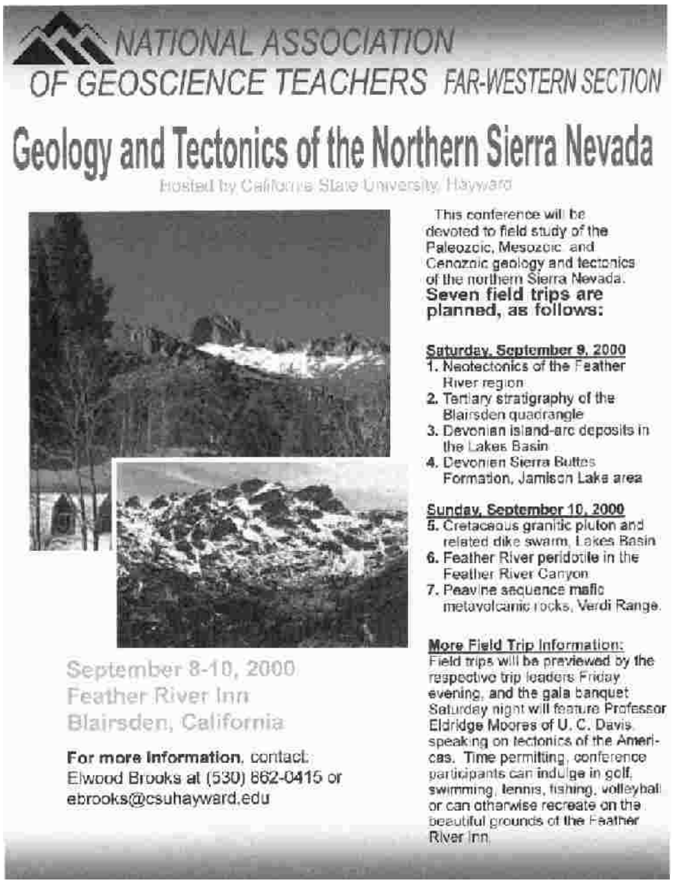
On Earth, glaciers and ice sheets (herein simply called glaciers) cover about 10 % of the land surface today, and they covered about 30 % during the recent ice ages. About 99 % of Earth's glaciers are remote from normal human activities and, until recent years, most people would have considered them scenically fascinating but of very little additional interest. However, glaciers are now known to affect all humanity for their influence on global climate, sea level rise and climate change. Volcanoes also interact with glaciers, sometimes with devastating local consequences. For example, for a period of a few hours towards the end of the very well-documented Gjálp eruption under the Vatnajökull glacier in Iceland in 1996, the discharge of meltwater was the second largest on Earth, exceeded only by the flow of the River Amazon and equivalent to about four times that of the Mississip Following ground-breaking but sporadic investigations between the 1940's and very early 1970's, mainly in Canada and Iceland, there was a virtual hiatus in research on terrestrial subglacial volcanism. However, during the 1970's and 1980's, extensive volcanic fields of Miocene and younger age were discovered throughout Antarctica (mainly West Antarctica), whose eruption coincided with the widespread development of a pan-Antarctic ice sheet. The Antarctic volcanic rocks represent an immense repository of palaeoenvironmental information. Many have now been investigated to document and understand the eruptive and depositional processes, and the hydraulics of subglacial eruptions. These investigations were greatly facilitated by, and built upon, the very elegant book by Bjornsson (1988), itself owing a huge debt to earlier seminal glaciological papers by Nye. A principal achievement of the research efforts of the late 1980's and early 1990's was the recognition that subglacial volcanic sequences could be grouped empirically into two main types, corresponding to eruptions beneath thin and thick glaciers. Thin glaciers (< 100-150 m) are formed mainly of permeable snow and firn (firn is snow in an intermediate stage of densification to ice). Any eruption-generated meltwater drains away continuously along the ice/bedrock surface, its thalweg essentially determined by bedrock topography. Resulting deposits comprise an "ideal" succession of glacial diamictite (representing coeval glacier bedload), followed upward by reworked syneruptive tephra derived from hydrovolcanic explosions and emplaced by traction currents and mass flows. Sequences are typically capped by lava and cogenetic hyaloclastite breccia. Each lithofacies package is common However, this orthodox explanation for the formation of tuyas is deficient. For tuyas to form, a period of water level stability is indicated. For a vault in glacier ice, the barrier will always be floated before the volcano breaches the lake surface. Lava deltas are unable to form. Thus, a third scenario is envisaged, involving a layered glacier containing a permeable upper layer of snow, firn and/or fractured ice. As long as the upper layer is relatively thick, the glacier will not be floated before the meltwater surface reaches it and overflows through the upper layer at its lowest point. Overflowing has only been documented in two eruptions: in 1969 on Deception Island, Antarctica (Smellie, paper in preparation), and 1996 in the Gjálp eruption. Each of the thick-glacier scenarios is an over-simplification. Meltwater is also lost by basal leakage, using pre-existing subglacial tunnels. Those tunnels become enlarged by thermal erosion during the earliest stages of eruption and the rate of meltwater accumulation in the vault is thus a balance between the melt rate of the overlying glacier and basal leakage. However, observed subglacial eruptions indicate that meltwater is created at a much faster rate than it leaks basally. For a layered thick glacier, therefore, meltwater will usually overflow and tuyas will form (if eruptions continue long enough). The thermodynamics of subglacial eruptions are very poorly understood. Rare published studies indicate that plenty of heat is contained in the erupted lava, with 1 unit-volume of magma sufficient to melt about 10 units of ice. However, the rapidity by which ice is melted is unexplained, and in real eruptions the rate is at least an order of magnitude faster than existing predictions. Mechanical turbulence of the water-filled vault, perhaps by convection of meltwater and quenched ash, could effect a more efficient heat transfer, but it is not the full answer. This is a major issue for which the thermodynamics urgently need further investigation. Lastly, practically all field studies and modelling have focused on small-volume basaltic eruptions beneath temperate ice sheets. There is a dearth of papers describing eruptions of more-evolved compositions and none consider the influence of polar ice. Efforts are now underway investigating subglacial rhyolite systems in Iceland and already they are highlighting significant differences in the sequences and processes involved compared with basaltic eruptions. Large-volume subglacial volcanoes (of any composition) have also largely escaped attention but will form an important focus of BAS geological research over the next five years, with investigation of a selected long-lived centre in northern Antarctic Peninsula. Because of the pivotal role of the Antarctic ice sheet in global change, a major 21st century challenge is to understand ice:volcano interactions in order to predict future configurations of the ice sheet and its role in the global climate system.

Spectacular hyaloclastite delta on James Ross Island, Antarctica, subject of research at BAS in 2 years' time. The cliffs are almost 200 m high.

Selected references and websites: Bjornsson, K. 1988. Hydrology of icecaps in volcanic regions. Vísindafélag Íslendinga, Societas Scientarium Islandica, 45. Gudmundsson, M.T., Sigmundsson, F. and Bjornsson, H. 1997. Ice-volcano interaction of the 1996 Gjálp subglacial eruption, Vatnajökull, Iceland. Nature, London, 389, 954-957. Höskuldsson, A. and Sparks, R.S.J. 1998. Thermodynamics and fluid dynamics of effusive subglacial eruptions. Bulletin of Volcanology, 59, 219-230. Jones, J.G. 1969. Intraglacial volcanoes of the Laugarvatn region, south-west Iceland. Quaterly Journal of the Geological Society, London, 124, 197-211. LeMasurier, W.E. and Thomson, J.W. 1990. Volcanoes of the Antarctic plate and southern ocean. American Geophysical Society, Antarctic Research Series, 48, Washington, D.C. Matthews, W.H. 1947. "Tuyas": Flat topped volcanoes in northern British Columbia. American Journal of Science, 245, 560-570. Skilling, I.P. 1994. Evolution of an englacial volcano: Brown Bluff, Antarctica. Bulletin of Volcanology, 56, 573-591. Smellie, J.L. In press. Lithofacies architecture and construction of volcanoes erupted in englacial lakes: Icefall Nunatak, Mount Murphy, eastern Marie Byrd Land, Antarctica. In: White, J.W. and Riggs, N. (eds) Lacustrine volcaniclastic sedimentation. International Association of Sedimentologists, Special Publication. Smellie, J.L. and Skilling, I.P. 1994. Products of subglacial volcanic eruptions under different ice thicknesses: two examples from Antarctica. Sedimentary Geology, 91, 115-129. Smellie, J.L., Hole, M.J. and Nell, P.A.R. 1993. Late Miocene valley-confined subglacial volcanism in northern Alexander Island, Antarctic Peninsula. Bulletin of Volcanology, 55, 273-288.

1996 subglacial eruption at Gjálp, Iceland: http://www.hi.is/~mmh/gos/ Ice:Volcano interactions on Earth and Mars, conference websites: http://wwwdev.wr.usgs.gov/USGSFlag/Land/IcelandMeeting/ and http://www.antarctica.ac.uk/public/geosci/iceland-meeting.html

Where glaciers have arrived too late to affect volcanic eruptions, they can still provide a useful service by incising terrain and polishing off the bedrock, which is what's happened in the northern Sierra Nevada, where this year's NAGT meeting and field trips will take place.



INTERNATIONAL ASSOCIATION OF SEDIMENTOLOGISTS

Regional Meeting
Dublin, Ireland

13-15 September 2000

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For the next issue of the newsletter, watch for a change of format to US Letter and arrival from Mississippi rather than New Zealand, as Ian takes over the newsletter for awhile.

Lots of information about the International Maar conference is now available online at:

http://www.uni-jena.de/chemie/geowiss/maar2000/

The most important bits are that the registration fee is very reasonable (DM 280 / 150 students), and there are a number of interesting fieldtrips planned:

Pre-conference trips 17-20 August

A1) Volcanology of the Westeifel maars, led by V Lorenz, FO Neuffer and H Lutz (DM 350)

A2) Tertiary maars around the Egergraben, led by V Cajz, K Goth and P Suhr (DM 300)

Post-conference trips 24-27 August

B1) Quaternary and Tertiary Eifel maars, Enspel (Westerwald) and Laacher See: Volcanology, sedimentology and hydrogeology, run as daytrips led by G Büchel, JFW Negendank, M Wuttke and L Viereck

B2) Tertiary maars as fossil deposits: Eckfeld, Messel, Randeck, Höwenegg, Öhningen, led by FO Neuffer, H Lutz, St Schaal, F-J Harms, N Micklich, G Gruber and V Lorenz (DM 350)

The last item is a bit of a teaser for an upcoming volume on Lacustrine Volcaniclastic Sedimentation, edited by JDL White and NR Riggs, to be published later this year as an International Association of Sedimentologists Special Publication. It is expected that many CVS members will find papers of interest in the volume, which ranges in coverage from intraglacial and intralacustrine eruptions through studies of a wide variety of volcaniclastically distinctive lacustrine deposits to the role of lakes in preserving distal tephra records.

SETTLING AND DEPOSITION OF 181 A.D. TAUPO PUMICE IN LACUSTRINE AND ASSOCIATED ENVIRONMENTS

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ABSTRACT

Pumice is an unusual geological material. It is of low density, its density can vary, reversibly, through time, and it is capable of floating in water. These properties result directly from the abundance and interconnectedness of vesicles, which in sedimentary environments contain air and water in varying proportions. The variable density and sometimes positive buoyancy of pumice in water lead to unusual transport properties which complicate attempts to interpret the energy of depositional environments in which it is deposited. Experimental settling of Taupo 181 A.D. pumice (Tilly, C. R., 1987, The sedimentology of the Taupo Pumice Alluvium Formation occurring in the lower region of the Hamilton Basin. Unpublished M.Sc., University of Waikato; Manville, V., White, J. D. L., Houghton, B. F. & Wilson, C. J. N., 1998, The saturation behaviour of pumice and some sedimentological implications. *Sediment. Geol.*, **119**, 5-16) confirms the general observation that larger clasts are the last to settle, indicating that progressive saturation and sinking of clasts from a pumice raft can produce a reverse-graded bed (saturation grading). Saturation of pumice clasts with water is mediated by inhomogeneities in the vesicle population, and in particular by more rapid transport of water through larger vesicles into the interiors of the clasts. Experiments designed to evaluate the behaviour of pumice clasts *after* they have become saturated show that although larger clasts retain slightly lower bulk density than smaller ones, fall velocities are nevertheless proportional to grainsize. Sorting of saturated pumice by fall velocity therefore produces normally graded pumice beds (redeposition grading). Subaqueous deposition of pumice from currents results in a range of conventional styles of crossbedding, but also produces distinctive steeply imbricated clast fabrics developed by the progressive growth of bedload cluster bedforms.