which is presently labeled "A1". There are three structural locations for the carbonate ion in type A-B CAp (space group $P6_3/m$). The channel carbonate is mainly in the closed (A1) configuration (IR bands at 1541 and 1449 cm^{-1}), but subordinate amounts are also located in an "open" vertical configuration (A2 carbonate; IR bands at 1563 and 1506 cm^{-1}). The type B carbonate ion is located close to the sloping faces of the PO_4 tetrahedron (IR bands at 1473 and 1406 cm^{-1}), and is charge compensated largely by the entry of carbonate into the stuffed A2 channel position. FTIR spectra correspond to CAp synthesized at lower P, and the present structures appear to be appropriate models for accommodation of the carbonate ion in bone and enamel.

V51E MCC: Level 1 Friday 0830h

Kinetic and Rheologic Controls on Transport and Eruption of Magmas I Posters

Presiding: **R Teasdale,** University of Bristol**; A Proussevitch,** University of New Hampshire

V51E-0318 0830h POSTER

Bubble size distributions in a convecting layer

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We have conducted a series of laboratory experiments to explore the bubble size distribution coupled with convection in a magma chamber. Boiling liquid heated from below exhibits two types of convection pattern depending on the viscosity. When the viscosity is sufficiently high, bubbles are distributed uniformly in the liquid, and the bubble size distribution becomes the power law type for large bubbles and exponential distribution for small bubbles. On the other hand, when the viscosity is low, bubbles are separated from the liquid layer, making a foam, and their size distribution is exponential for large bubbles and unimodal for small bubbles. These experimental results suggest that the bubble size distribution is determined whether the viscous drag of the magma is sufficiently high to trap bubbles.

V51E-0319 0830h POSTER

Experiments With Bubble Nucleation and Growth in Dacitic Melts at an Initial Pressure of 1 Kb and 875oC

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Two sets of experiments with Mount St. Helen's dacitic pumice (SH-118) were conducted to understand the kinetics of bubble nucleation and growth in dacitic melts. Powdered samples of dacite were first equilibrated with excess water at an initial pressure of 1 Kb and 875oC for 48 hours. After 24 hours, in the first set of experiments the pressure was dropped 30 MPa and 300, 900, and 2700 seconds were allowed for bubble nucleation and growth. The pressure was dropped 50 MPa, in the second set of experiments and 900 and 2700 second were allowed for bubble nucleation and growth. Results of the 30 MPa pressure drop experiments for 300, 900, and 2700 seconds residence times were: total number of bubbles (nT) were 6.41E3, 5.23E3, and 3.37E3 mm-3; growth rates (G) were 5.03E-5, 1.56E-5, and 5.97E-6 mmsec-1; nucleation rates (J) were 21.1, 5.81, and 1.25 mm-3sec-1; and initial bubble densities (no) were 4.25E5, 3.73E5, and 2.09E5 mm-1. Results of the 50 MPa pressure drop experiments for 900 and 2700 seconds residence times were: nT were 2.10E3 and 4.10E3 mm-3; G were 3.01E-5 and 8.26E-6 mmsec-1; J were 2.34 and 1.52 mm-3sec-1; and no were 7.75E4 and 1.84E5 mm-1. These data indicate that as the pressure drop increases from 30 to 50 MPa at 900 sec G is increasing and no, J, and nT are decreasing suggesting that bubbles are growing faster and coalescing. On the other hand, when pressure drop increases from 30 to 50 MPa at 2700 sec G, J, and nT are increasing and no is decreasing slightly. This suggests that the bubbles faster but are not coalescing.

V51E-0320 0830h POSTER

Crystallization of microlites and degassing during magma ascent: Constraint on fluid mechanical behavior of magma at Tenjo Eruption, Kozu Island

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Vesiculation, degassing and decompression induced-crystallization in conduit strongly control the eruption dynamics of magma. A key point in understanding the dynamics of eruption is the coupling between vesiculation and microlite crystallization. Textural and compositional analyses of clasts gave the insight into the physical processes of magma. In particular, both bubble and microlite number density may constrain not only the coupling between crystallization and vesiculation processes but also fluid mechanical behavior of magma. We carried out textural (bubble and crystal) and compositional analysis of vesicular pumices from Tenjo pyroclastic flow, which erupted in 838 A.D on Kozu Island, Japan. Vesicular pumices in one flow unit (apparent density 300 2400kg/m3) can be classified into three types by their vesicle shape and vesicularity: type I: high vesicularity and small spherical bubbles; type II: similar vesicularity as type I, however, bubbles are coalesced; type III: low vesicularity and highly deformed bubbles. The microlite volume fraction (DRE converted) increases from type I to type III 0.06, 0.08, 0.10-0.15, respectively, corresponding to their vesicular texture. However, the number density of the microlites remains the approximately constant regardless of vesicular types. This fact means that the microlite volume fraction is controlled not by the number density (i.e., nucleation process), but by the size (i.e., growth process) of the microlite. Water content determination shows that the three types of vesicular types have almost the same value (2.4-2.76 wt.%). These facts imply that, although the three types were quenched at almost the same depth in conduit, each type experienced a different crystal growth history. If the crystal size is influenced only by the growth time, then the difference in crystal size can be attributed to the conduit flow process. Since, in the Poiseuille flow, there is the gradient of ascent velocity across the conduit, the different growth times of crystal can be explained reasonably by the flow pattern in conduit. Namely, in the inner part of the conduit, the crystal growth time from nucleation to quenching may be shorter because the ascent velocity of the magma is higher. On the other hand, at the margin of conduit where the ascent velocity is lower, the crystal growth time becomes longer. Thus, if we think that type I, II and III were distributed from the inner part to outer part sequentially, then the textural facts can successfully constrain the fluid mechanical behavior in conduit for the Tenjo eruption.

V51E-0321 0830h POSTER

Natural Observations on the Link Between Syn-eruptive Degassing and Microlite Formation in Rhyolitic Obsidians

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Quenched silicic melts often contain microlites interpreted to form syn-eruptively, "in response to loss of a hydrous vapor phase" (Swanson et al., 1989). Based on this link between degassing and crystallization, microlite textures have been widely used to infer the extent magmatic degassing, magma residence times, and magma rise rates. Because the growth of a microlite population depends not only on the imposed undercooling, but also the time available to form and grow nuclei, the possibility exists that two or more parcels of magma that underwent the same degree of degassing could exhibit drastically different groundmass textures, owing to different rise rates and/or residence times. Thus, inferences regarding eruption dynamics based on groundmass textures alone may not be straightforward, and some independent measure of the amount of degassing should accompany textural measurements. In this work, we measure microlite textures and corresponding volatile concentrations in pyroclastic and effusive obsidians from the Inyo volcanic chain, CA in order to determine the extent to which microlites record syn-eruptive degassing. Direct comparisons of clinopyroxene and plagioclase microlite modes, crystal size distributions, and number densities with preserved volatile contents determined by FTIR allow us to test the sensitivity of microlite textures to the degassing history and ascent dynamics of the Inyo magma. Our samples consist of 110 obsidians collected tephra and dome deposits of the 550-650 yr.b.p. eruption of the Inyo Volcanic chain. Obsidians are characterized by low bulk volatile contents (0.13 to 1.8 wt.% H_2O) and large variations in mineralogy, mode, number density, and crystal size. Clinopyroxene is the dominant microlite phase in most dome and tephra samples. However, approximately 30% of samples also contain abundant plagioclase in the microlite assemblage. Average pyroxene and plagioclase number densities (N_v) define two general patterns when plotted against dissolved H_2O content: 1) a bell-shaped region defined by samples erupted from the Obsidian Dome vent, and 2) a relatively linear, negatively sloping envelope consisting of data from both Obsidian Dome and South Deadman vents. In the bell-shaped distribution, peak N_v ($10^9/cm^3$) occurs at H_2O contents between 0.6 and 0.7 wt.%. Microlite contents drop off by one order of magnitude on either side of this maximum. This hump-shaped distribution may record two stages of syn-eruptive crystallization: 1) an early nucleation-dominated regime characterized by a sharp increase in the nucleation rate with volatile loss (undercooling) and; 2) a later stage marked by declining nucleation rate and a transition to growth dominated behavior with decreasing dissolved H_2O. In the second array, average (N_v)increases with decreasing H_2O, although number densities are are uniformly low ($10^8/cm^3$) compared to obsidians in the bell-shaped trend. Apparently, crystal nucleation did not proceed extensively, despite the large undercoolings imposed by degassing. Rapid ascent and therefore a relatively short crystallization interval prior to quenching may explain these microlite-poor obsidians. Our analysis shows that obsidians degassed to the same final values, may develop drastically different final textures and modes, owing to different rates of magma ascent.

V51E-0322 0830h POSTER

Devolatilization Induced Crystallization Experiments of Hydrous Basaltic Magma, Implications for Lava Flow Emplacement

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Lava flow solidification occurs by degassing induced crystallization and with external cooling; as a result both are potential controls for groundmass crystallization during ascent through the conduit and extrusion of lavas. Decompression controlled crystallization rates have been determined experimentally for more evolved magma compositions but are relatively unknown for basaltic magmas. Isothermal decompression TZM experiments have been used to constrain the general style and rates of devolatilization induced crystallization in a basaltic magma. Initial experiments determined plagioclase liquidus temperatures for a range of water contents from dry to supersaturated. The observed liquidus phase is aluminus spinel, followed by clinopyroxene, then plagioclase. Plagioclase-in temperatures vary from 1175 C at 1atm (dry) to 1050 C at 200 MPa (P H2O = P total). The effects of devolatilization are modeled by decompressing to 1 atm from 200 MPa, 100 MPa, and 50 MPa at a rate of 100 MPa/hr. These pressures are consistent with depths at which basaltic magmas are likely to begin ascent, based on petrologic evidence (1-2) and decompression rates are consistent with reported basaltic dike propagation of 1 m/s (3). Initial results show that crystal morphology and abundance are not significantly different for experiments decompressed from 200 MPa and 100 MPa suggesting that most devolatilization occurs in the final stages of decompression. Experiments produce up to 20 % groundmass plagioclase crystals which range from 1-20 microns in length. Results of devolatilization-induced crystallization experiments, in combination with external cooling models for groundmass crystallization will

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produce a more complete understanding of the solidification of hydrous basaltic lavas. This in turn will improve the characterization of basaltic magma transfer prior to eruption, and in particular at shallow depths where degassing becomes important. These results are part of ongoing efforts to describe the relationship between groundmass crystallinities and development of a'a and pahoehoe flow morphologies. (1) Geist et al 1998; (2) Bureau et al 1998; (3) Rubin 1993

V51E-0323 0830h POSTER

Pressure Changes Associated with Dike Intrusion: Effect of Vesiculation in Magma

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Vesiculation in magma, which has been studied to understand observed geologic samples, is one of the most probable candidates for driving force of magma migration beneath active volcanoes. By incorporating elasticity of the surrounding medium into the bubble growth model proposed by Prousevitch et al. (1993), magma pressurization is evaluated for dike intrusion. Dike is assumed to be a crack filled with magma buried in infinite elastic medium, and magma consists of melt and numerous small spherical gas bubbles. Melt is compressible liquid saturated with volatiles such as water, and the gas in bubbles is approximated as a perfect gas. When magma is pressurized, a stress concentration occurs at the elastic body of the crack tips, and the crack extends its length in a short time. This causes a pressure drop in magma when volume of magma is constant during the extension. With the elapse of time, the gas bubble grows to remove the pressure difference between the gas bubbles and melt. Finally, the pressures of the gas and melt reach an equilibrium condition. From the mass conservation of water in magma and pressure balance between gas bubbles, melt and surrounding elastic medium, the magma pressure and bubble radius in the final stage when bubble growth reach an equilibrium are related to the initial condition of magma and the pressure drop induced by dike intrusion. Calculation results show that the pressure drop caused by a dike intrusion is recovered by the excess pressure of gas bubbles when initial bubble radius is sufficiently small. Pressure drop is effectively recovered by vesiculation for thick dikes under a low confined pressure. These pressure recovery processes suggest that the dike can migrate and extend without a new supply when magma is rich in tiny bubbles of volatiles.

V51E-0324 0830h POSTER

Thermal Modeling of the Cooling History of a Basalt Lava Flow: Effect of Flow Shape and Thermal Perturbations Induced by Inflation Fissures

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Thermal modeling of cooling basalt lava flows has typically been undertaken using 1-D analytical heat flow models for an infinite plane. In such models, flows are conceptualized as having a finite thickness, but are infinitely wide and infinitely long (i.e., "sheet flows"). These analytical models typically accounted only for conductive heat loss, or attempted to approximate the effect of a sudden convective heat loss by redefining the conduction boundary conditions at some point during the cooling history. Although such models have proven useful for the examination of sheet flows such as those of the Columbia River flood basalts, they are inadequate for considering the cooling history of low-volume flows having small (meters to a few 10s of meters) in-plane dimensions (i.e., small aspect ratios, or width/thickness). In such flows, cross-sectional flow shape exerts a strong control on the thermal evolution of the flow during cooling, and hence on the cooling fracture patterns that develop in response to thermal stresses. The advent of numerical thermal models has recently enabled other researchers to predict isotherm patterns in lava flows with in-plane lateral peripheries. We build on these numerical modeling efforts by examining the effect of variable flow shape on lava flow cooling history. We also explicitly model the effects of convective heat loss through inflation fissures that develop in response to inflation of the lava flow during extrusion. This choice of controlling factors is predicated by observations of flow shapes and fracture characteristics of low-volume basalt flows of the Eastern Snake River Plain (ESRP), Idaho. We use the finite element code ABAQUS to model the thermal evolution of small aspect ratio flows, both with and without an inflation fissure. The program accounts for radiation of heat and convection at exposed boundaries, latent heat of crystallization, and conduction of heat into the underlying substrate. In models that do not include an inflation fissure, the results predict that the final portion of a lava flow to solidify occurs slightly below the center of the flow, in agreement with field observations and previous analytical and numerical model results. Using the assumption that cooling fractures grow approximately perpendicular to isotherms, predicted isotherm patterns can be reconciled with fracture characteristics in cooled ESRP flows. The incremental introduction of an inflation fissure during cooling results in a one-month shorter time to complete solidification and significantly perturbs the isotherm patterns, and hence cooling fracture characteristics, of the flow. Furthermore, the inflation fissure dictates the location of the final portion of the flow to solidify (the "lava core") and may even cause the flow interior to segment into multiple lava cores. Based on these model results and our field observations of inflation fissure geometries, we hypothesize that the lava cores ultimately undergo rapid convective cooling and intense fracturing in response to being pierced by an inflation fissure, resulting in the development of a highly fractured zone (or "entablature") slightly below the flow center.

V51E-0325 0830h POSTER

Rheological Cut-Off Temperatures in Nyiragongo lavas: Dynamic crystallisation experiments.

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The lavas of the 2002 eruption of Nyiragongo were highly fluid at the vent. The ultimate extent of flow of such lavas is further constrained by the rapid transformation of portions of the lava into a homogeneous crust of constant thickness, composed of the fine-grained products of a multiphase paragenesis. We have sampled these lavas in the field. A selection of these materials have been subjected to high temperature rheological investigation in the rheological facilities of the Experimental Volcanology lab at Munich. Two types of investigation have been performed. Firstly, the equilibrium viscosities of the Nyiragongo liquids have been determined as a function of temperature, from superliquidus (and supereruptive) temperatures down to the glass transition. Combining the techniques of concentric cylinder and micropenetration viscometry yield viscosity curves spanning 10^{0} - 10^{12} Pa s. Secondly, dynamic cooling rheological experiments have been performed to investigate the influence of the kinetics of crystallisation of Nyiragongo lavas on their rheological response. The progress of crystallisation of Nyiragongo lavas leads to a transition in their rheological response from low viscosity (10^{1}.5 Pa s) Newtonian fluids to rigid solids. This we name the "rheological cut-off".The dynamic experiments were performed at constant cooling rates. Despite their kinetic/disequilibrium nature, they yield a highly reproducible dependence of the rheological cut-off temperature range as a function of constant cooling rate. The temperature range of the transition is very restricted (ca. 20K) for a given experiment. This is presumably due to the very rapid and efficient crystallisation in that temperature interval. Significant levels of F and Cl in these lavas likely facilitate mineralisation in these lavas. The rheological cut-off temperature ranges from 1050 to 1000°C for cooling rates in the range of 1 to several tens of K/min. These results thus provide quantitative temperature constraints for the development of lava crusts in Nyiragongo lavas. These will be incorporated in models for the simulation of conduit and surface flow of such lavas.

V51E-0326 0830h POSTER

The Role of Magma Mingling in Strombolian Explosions: an Example From September-October 2002

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Unusual eruptive conditions during September-October 2002 permitted us to collect clast populations ejected during single explosions and closely spaced series of explosions at Stromboli volcano. The clast populations have a range of textures and vesicularites suggesting melt resident in the shallow conduit was a mixture of rising, actively vesiculating magma, and material that had stagnated and partially outgassed in this environment. Explosions ejected clasts composed of either type of melt independently, in addition to clasts formed from mingling of both the freshly arrived and long resident magmas. We use measurements of vesicle size and shape to constrain the vesiculation and degassing processes, and to look at the influence of the long resident melt on the eruption process.

V51E-0327 0830h POSTER

A Physical-Experimental Model for Small-Scale Basaltic Vulcanian Eruptions

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In the last period of its summer 2001 flank activity Mt. Etna produced ash explosions not common at this basaltic volcano. The explosions took place at a new vent at 2550 m.a.s.l. and followed Strombolian and effusive activity. At first the ash erupted as a continuous, pulsing plume a few km high, occasionally undergoing small-scale, partial collapses. Afterward the frequency and intensity of the explosions decreased to isolated events, gradually fading to an end. Each explosion produced mostly wind-driven ash and subordinate blocks ballistically emplaced close to the vent. The final deposit is an ash layer 20 cm thick at 50 m from the vent. Both the ash and the blocks are poorly vesicular with a microcrystalline matrix. This type of activity, deposit, and products closely match, although on a smaller scale, those of Vulcanian explosions: hence we hypothesize that a similar mechanism of overpressurization of a magma plug was at work at Etna. Petrological observations indicate that the plug formed by gradual crystallization of the stagnant magma at the top and at the borders of the conduit after the Strombolian and effusive activity. In order to model the ash explosions we applied three independent techniques to estimate the overpressure in the exploding plug: 1) HP-HT shock tube experiments to determine the pressure differential required to fragment the plug material; 2) calculation of the overpressure generated by plug crystallization; 3) application of two physical models for vulcanian eruptions using the range of ballistic blocks.
To measure the minimum pressure differential required to fragment them, we heat and pressurize cylindrical cores from the blocks at T up to 800-900°C and P up to 25 MPa inside a shock-tube apparatus, and then suddenly decompress them to ambient conditions. The pressure threshold varies strongly with sample porosity, from 22.5 MPa at 4% porosity to less that 5 MPa at 20%. Since these values came from the dense blocks that were not fragmented to ash, we assume the lower value as representative of the ash-forming magma.
The ash from the explosions has 35 vol.% more microlites than that from Strombolian activity. Applying available models of crystallization-induced overpressurization and find that crystallization of 35 vol.% of microlites is enough to pressurize a basaltic magma to 4-6 MPa at a depth of 100 m ca..
Finally we use the range of ballistic blocks to estimate their exit velocity that, in turn, can be related to the pressure in the conduit. Using realistic values for the ejection angle, shape and density of the blocks, and other ambient conditions, the maximum range of 450 m for blocks of 60 cm corresponds to a muzzle velocity of 80 ms^{-1}. Using this value as an input, two different models for vulcanian eruptions give an initial pressure of 4-6 MPa in the assumption that the volatile content of magma in the plug is in the order of 0.1 wt.%. This assumption is in agreement with petrological evidence that the plug formed by the accumulation of largely degassed magma.
In our model, crystallization of 35 vol.% microlites in a magma with 0.1 wt.% of volatiles at a depth of 100 m increase the overpressure in the plug up to 4-6 MPa. At this point the fragmentation threshold is reached and an explosion occurs, ejecting blocks at speeds up to 80 ms^{-1}. Notwithstanding the fact that other processes may contribute pressurizing the plug, we believe that the convergence of three independent methods under reasonable assumptions strongly supports our model.

V51E-0328 0830h POSTER

Laboratory experiments on columnar jointing

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The mechanism causing columnar jointing has remained an enticing mystery since the basalt columns of the Giant's Causeway in N. Ireland were first reported to science in the 17th century. This phenomenon, in which shrinkage cracks form a quasi-hexagonal arrangement, has been shown to produce columns in starch, glass, coal, sandstone, and ice, as well as in a variety of lava flows. This suggests that this pattern-forming process is very general in nature. However, most studies of columnar jointing have been confined to field studies of basalt flows. Following Muller, we have experimented with desiccating corn starch in an effort to understand this pattern from a more general point of view. The diffusion and evaporation of water in starch is thought to be analogous to the diffusion and extraction of heat from a basalt flow. By combining direct sampling and x-ray tomography, fully 3D descriptions of columnar jointing were obtained with starch samples. We have characterized the pattern with several statistical indices, which describe its structure and relative disorder. These methods can resolve the ordering of the colonnade near the free surface. We identified two distinct mechanisms by which the mean column area increases during pattern evolution. We found both a slow, almost power-law increase in column area, as well as episodes of sudden catastrophic jumps in scale. The latter suggests that the column scale is not a simple single-valued function of drying rate, but rather a metastable state subject to hysteresis. Such metastable behaviour might explain a fundamental question about columnar jointing – why the columns are so regular in the direction of their growth. Moreover, these experiments may help discriminate between the various theoretical models of this pattern forming process. Finally, our results lead to predictions that could be tested by field measurements on basaltic colonnades.

URL: http://www.physics.utoronto.ca/nonlinear

V51E-0329 0830h POSTER

Effects Of Conduit Flow Parameters On Vulcanian Explosion Characteristics

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Previous work produced numerical models of Vulcanian explosions which occurred in 1997 at Soufrière Hills Volcano, Montserrat. Plume evolution and velocities were calculated for the well-documented and typical explosions of August 6th and 7th 1997, and these data and other observations were compared to transient, axisymmetric, multi-phase flow simulations of coupled conduit evacuation and pyroclastic dispersal. Pre-explosion conduit conditions were estimated from Montserrat data, using a simple gas solubility law and assuming that conduit magma flow had stagnated with a constant overpressure prior to the explosions. The numerical simulations of the explosions resolved highly unsteady vent exit conditions such as velocity, pressure and mass flux. Our simulations produced behavior which generally mimicked the observed explosions. The best match to the observed and measured explosion parameters employed an intermediate conduit permeability value. Results suggest that a modest amount of volatile depletion in the conduit was an important factor in influencing the strength and style of the Vulcanian explosions on Montserrat. Ongoing work, which is presented here, uses a dynamic model of the conduit, rather than assuming that flow had stagnated. The new conduit model allows for magma viscosity and density changes due to degassing, crystallization and the presence of bubbles as the magma rises in the conduit, creating a non-linear overpressure gradient with depth. The first aim of this project is to examine conduit model parameters to determine which significantly affect the steady-state conduit pressure and gas volume fraction profile. Important parameters presented here are permeability (both vertical and horizontal), chamber crystal volume fraction, crystal growth function (curve fits of experimental results), magma flux rate and bubble-bearing rheology parameters, such as bubble size. The second aim is to determine to what degree such added complexity in the conduit model controls the resulting explosion simulation results. The first round of comparisons suggests that added rheological complexity does not significantly affect the energy of the explosion. For example, plume ascent velocities and collapse timing and height of a simulation with initial conditions determined by a rheologically complex model, but without permeability, were quite similar to those derived from our original, stagnated, non-permeable conduit. However, plume shape and collapse style were affected by the new conduit formulation. These results suggest that the strength of the explosion is particularly sensitive to the permeability of the conduit system, but is not sensitive to vertical pressure profile, while, on the other hand, the style of the explosion plume and fountain collapse is sensitive to both the conduit permeability and pressure profile. Simulated Vulcanian explosions resulting from the more complex dynamic conduit model, including effects of permeability, are therefore presented and compared against simulations derived from the simple stagnated, yet also permeable, conduit profiles. Again, results suggest that water vapor volume fraction is more important than complex rheology in predicting explosion strength.

V51E-0330 0830h POSTER

Exploration of eruption mechanisms through parametric sensitivity analysis: Using a numerical model as a diagnostic tool

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Numerical models can be useful for exploring the dependence of eruption timing and style to variations in magma chemical and physical characteristics, as well as to geometry of the system. We have developed a model that can be used for this purpose ("Bubbledrive") and have applied it to a number of scenarios involving rhyolitic systems. We have tested the sensitivity of eruption style to variations in conduit depth and radius, volatile diffusivity in the melt, melt viscosity, magma recharge from below, and decompression triggers. The results show that after the initiation of eruption, there is a gradual acceleration stage in case of cylindrical conduit shapes. Exit velocity is approximately a linear function of time, and discharge rate is close to constant. The difference between velocity and discharge reflects the increasing vesicularity of the erupting magma during degassing and bubble growth. After a climax in exit velocity, the eruptions quickly cease. As such, these results suggest that an empirical equation can be formulated that describes exit velocity in terms of eruption duration and an acceleration factor, which, in turn are functions of conduit radius, depth, diffusivity, viscosity, etc. The above relations do not apply to magma systems with more "realistic" or complex conduit geometries, such as those that include a magma chamber. In the latter case, initialization is followed by quasi-steady state eruption of different intensity over extended time (about 80% of eruption cycle). This relatively uniform stage of eruption is maintained by the degassing of magma within the chamber that feeds the upper conduit. The uniform stage of eruption ends abruptly when the magma chamber is degassed. An eruption spike appears as an explosion near the end of degassing of the chamber. This spike begins when the overlying conduit is filled with foam or gassy spray that provides little overburden; this leads to rapid decompressive degassing of the chamber with little resistance to the flow from the overlying conduit. The maximum explosion occurs as the foam layer moves into the chamber. These results of numerical modeling suggest that observations or monitoring systems could be used most fruitfully in the areas of conduit geometry. At present, it is simpler to develop numerical models of specific conduit geometries than it is to directly probe and map them in natural systems. This highlights the importance of monitoring systems for specific volcanic systems.

V51E-0331 0830h POSTER

Do the fractal dimensions of evolved lava-flow margins distinguish endogenous and exogenous growth?

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Although there are recorded observations of active dacitic domes at Mount St. Helens, Soufriere, St. Vincent and Santiaguito, there is as yet no direct observation of an active rhyolite flow, dome or coulee. Thus, we must use numerical models and/or laboratory simulations to constrain the emplacement of evolved lavas. We have used fractals to describe the planforms of evolved flows and domes (both naturally occurring and simulated laboratory flows) in an attempt to quantify their emplacement styles. Bruno et al. [1994] used fractal analysis of basaltic lava flow margins and determined that a´a flows correspond to a fractal dimension (D) of 1.05-1.09 and pahoehoe flow margins display D = 1.13-1.23. Based on only a few examples, they concluded that evolved flow margins are not fractal. However, only a small number of evolved flows were examined and these were emplaced on relatively steep ($>5^\circ$) slopes. More recently it has been suggested that the D ranges allocated to a´a and pahoehoe actually describe simple or complex emplacement, respectively. We have measured aerial images of evolved lava flows in the Cascades, the Inyo domes and the Andean Central Volcanic Zone to test the hypothesis that D values for lava flow margins reflect emplacement style rather than surface morphology. Preliminary results indicate that some evolved flows and domes do indeed exhibit a fractal behavior. A flow margin is determined to show fractal behavior if the R^2 value calculated on a Richardson plot of the margin is >0.95. The flows/domes that do exhibit fractal behavior fall within the range of 1.055 and 1.097. This range is almost identical to that of the simple flow emplacement (a´a-like), which may be indictative of endogenous (rather than exogenous) growth. Analyses of simulated flows in the laboratory will be used to further test this hypothesis.

V51F MCC: Level 1 Friday 0830h

Applied Volcano Hazards Assessments and Methods Posters

Presiding: **R Wessels,** U.S. Geological Survey Alaska Volcano Observatory

V51F-0332 0830h POSTER

Forwards and Backwards Modelling of Ashfall Hazards in New Zealand by Monte Carlo Methods

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We have developed a technique for quantifying the probability of particular thicknesses of airfall ash from a volcanic eruption at any given site, using Monte Carlo methods, for hazards planning and insurance purposes. We use an established program (ASHFALL) to model individual eruptions, where the likely thickness of ash deposited at selected sites depends on the location of the volcano, eruptive volume, column height and ash size, and the wind conditions. A Monte Carlo formulation then allows us to simulate the variations in eruptive volume and in wind conditions by analysing repeat eruptions, each time allowing the parameters to vary randomly according to known or assumed distributions. Actual wind velocity profiles are used, with randomness included by selection of a starting date. We show how this method can handle the effects of multiple volcanic sources by aggregation, each source with its own characteristics. This follows a similar procedure which we have used for earthquake hazard assessment. The result is estimates of the frequency with which any given depth of ash is likely to be deposited at the selected site, accounting for all volcanoes that might affect it. These numbers are expressed as annual probabilities or as mean return periods. We can also use this method for obtaining an estimate of how often and how large the eruptions from a particular volcano have been. Results from ash cores in Auckland can give useful bounds for the likely total volumes erupted from the volcano Mt Egmont/Mt Taranaki, 280 km away, during the last 140,000 years, information difficult to obtain from local tephra stratigraphy.

V51F-0333 0830h POSTER

Lava extrusion rates from handheld infrared imagery

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