following standard methods. Uranium and some thorium measurements were obtained using a Micromass Sector54 TIMS equipped with a WARP filter. Many of the thorium measurements were obtained with a GV Isoprobe MC-ICP in the "soft extract" mode using the Cetac Aridus nebulizer. The Isoprobe provided greatly improved sensitivity and accuracy relative to the TIMS instrument. Uranium concentrations in quartz, opal and calcite separates range from 0.001 ppm to 1.227 ppm, and Th from 0.0001 to 3.278 ppm. Ages were obtained from isochron plots of calcite-opal/quartz pairs, or from a given group of samples assumed to share the same initial or detrital $^{230}Th/^{238}U$ and $^{234}U/^{238}U$. The resulting preliminary ages are: Group 1: 5 ka; Group 2: 4 ka and 5 ka; Group 3: 97 ka; Group 5: 4.7 ka and 0.4 ka. The relatively young ages close to 5 ka for most samples from Groups 1, 2, and 5 are consistent with expectations based on the presence of active fumaroles that indicate a current heat source, as well as geologic observations for recent faulting that has provided conduits for fluid flow. The older age of 97 ka from group 3 travertine deposit is also consistent with expectations, as cold seeps and the absence of fumaroles indicate a lesser degree hydrothermal activity. These results show that U-series chronology is an important tool for understanding the longevity of hydrothermal systems and the time-scales of fluid-flow in the crust.

V51D MCC: Level 1 Friday 0830h

Medical Mineralogy Posters *(joint with MR)*

Presiding: **G S Plumlee,** U.S. Geological Survey

V51D-0313 0830h POSTER

Minerals, Tobacco and Smoking-Related Disease

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As much as 8% (by dry weight) of commercial tobacco is mineral, and the view that minerals are inert, playing no more than a passive role in smoking-related disease, is challenged. An inventory of minerals in tobacco is presented and an interpretation of their sources given. Using elemental abundances the relative contributions of natural and anthropogenic sources to the commercial product is quantitatively modelled relative to average crustal abundances. A framework is presented for investigating the potential ways in which minerals with, or acquire, toxic properties behave in the smoking environment. In order to represent a potential hazard any mineral (or mineral reaction product) with suspected toxic properties must partition into smoke and be respirable. For inhalation a significant proportion of the particles must be smaller than 10 microns. Three categories of potential hazard are recognised: 1. Minerals with intrinsic toxic properties. Quartz can amount to 1% or more in some cigarettes and is defined as a human carcinogen by the IARC. It is not likely to represent a hazard as its grain size is probably too coarse to be respirable. However talc, also a Type 1 carcinogen when it is contaminated with asbestos, is a common constituent of cigarette paper and may be of respirable size. Some other minerals also fall into this category. 2. Minerals that generate toxic products on combustion. Examples are the biominerals calcium oxalate monohydrate (whewellite) and dihydrate (weddellite), which amount to about 5 wt% of popular UK brands. These minerals decompose at tobacco combustion temperatures yielding large quantities of carbon monoxide. A substantial fraction of the CO budget of UK cigarettes may derive from this source. 3. Minerals that acquire toxic properties on combustion. Little is known about free radical generation on mineral surfaces during tobacco combustion, but the devolatilisation of calcic phases (carbonates and oxalates) creates oxide particles with surfaces highly adsorbent to polycyclic aromatic hydrocarbons (PAH). Calcic mineral particles are two orders of magnitude more abundant in smokers' lungs compared with non-smoking controls in residents of Vancouver. Such particles may thus be potential agents for the delivery of PAH carcinogens, including benzo(a)pyrene, to the lungs. None of the potential hazards listed above has yet been properly evaluated.

V51D-0314 0830h POSTER

Respiratory Health Effects of Volcanic Ash - a new Approach

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Attempts to characterise the toxicity of volcanic ash have focused on the presence of the crystalline silica polymorph cristobalite, which is known to cause silicosis and lung cancer in industrial settings. Within the lung, it is the surface of the particles which will react with endogenous molecules. Free radicals, produced on particle surfaces, can react with DNA and other cellular components, instigating a chain of toxic events. For the first time, the ability of volcanic ash to form free radicals has been assessed using Electron Paramagnetic Resonance techniques specific to the hydroxyl radical. Respirable (< 4 microns) crystalline silica, separated from volcanic ash from the Soufriere Hills volcano, Montserrat, West Indies, did not produce hydroxyl free radicals or surface radicals. However, the ash, itself, generated up to 3 times more hydroxyl radicals than a quartz of known toxicity. The cause of the reactivity is reduced iron on the surface of iron-rich minerals such as amphiboles and pyroxenes. Fresh volcanic ash generates more free radicals than weathered volcanic ash which will have oxidised (and leached away) surface iron. These results have implications for volcanic health hazard research as it was previously assumed that volcanoes which did not produce respirable crystalline silica presented a lesser respiratory health hazard. The International Volcanic Health Hazard Network (IVHHN) promotes research into the health effects of volcanic emissions. Under the auspices of IVHHN, volcanic ash samples from volcanoes world-wide are being analysed for surface reactivity, grain-size distribution and composition to form a comprehensive database for use by volcano observatories, emergency managers, medical practitioners and researchers. The results will highlight volcanoes which have the potential to cause a respiratory health hazard through generation of iron-catalysed free radicals, as well as more conventional markers such as concentration of respirable particles. At the onset of new eruptions, the database will be used to aid the rapid assessment of health hazard from volcanic ash.

URL: http://eis.bris.ac.uk/~glcjh/ivhhn

V51D-0315 0830h POSTER

Mineralogical Studies Related to Endemic Diseases in Rural P. R. China

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Domestic combustion of coal for heating and cooking is mostly confined to the world's developing countries and probably involves about 1 billion persons in China, India, Indonesia, and Africa. Various endemic diseases affecting millions of people involving arsenic, selenium, and fluorine poisoning have been associated with domestic coal combustion in rural China. We have investigated the relationship between mineralized coals (and stone coals) and disease occurrences in Guizhou and Hubei Provinces. The mineralogy of the coals has been studied by a wide variety of techniques, including optical petrography, scanning electron microscopy, electron microprobe analysis, ion probe, Synchrotron XANES-EXAFS, and Raman spectroscopy. Arsenic enrichment (up to 3 weight percent) in Upper Permian Longtan Formation coals, southwestern Guizhou Province, occurs in both 3+ and 5+ valence states. Arsenic occurs in arsenopyrite, pyrite, Al-phosphate, scorodite, Fe-oxides, and as an organically-bound species. Fluorine poisoning, much more widespread than arsenic-poisoning, is related to burning F-rich coals and F-rich clays as admixtures. Mineralogical and chemical analysis suggests that the clays contain the fluorine probably substituting for the hydroxyl group. Localized selenium poisoning in Hubei Province is related to Se-rich stone coals. The selenium occurs as a native element and in rare mandarinoite. In these three cases, knowledge of the paragenesis and mineralogy of the element enrichment in coal was vital to help understand and mitigate the endemic diseases. For the situation concerning arsenic and selenium poisoning, suspect coals have been identified and mining from these deposits has been curtailed. Fluorine has been a much more difficult problem for the local public health officials as both the coal and clay in the burning admixture can contain high fluorine. Regional geochemical and mineralogical studies will help to define coal and clay with low fluorine, suitable for domestic use.

V51D-0316 0830h POSTER

The Toxicological Geochemistry of Dusts, Soils, and Other Earth Materials: Insights From In Vitro Physiologically-based Geochemical Leach Tests

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Exposure to mineral dusts, soils, and other earth materials results in chemical reactions between the materials and different body fluids that include, depending upon the exposure route, lung fluids, gastrointestinal fluids, and perspiration. In vitro physiologically-based geochemical leach tests provide useful insights into these chemical reactions and their potential toxicological implications. We have conducted such leach tests on a variety of earth materials, including asbestos, volcanic ash, dusts from dry lake beds, mine wastes, wastes left from the roasting of mercury ores, mineral processing wastes, coal dusts and coal fly ash, various soils, and complex dusts generated by the World Trade Center collapse. Size-fractionated samples of earth materials that have been well-characterized mineralogically and chemically are reacted at body temperature (37 C) for periods from 2 hours up to multiple days with various proportions of simulated lung, gastric, intestinal, and/or plasma-based fluids. Results indicate that different earth materials may have quite different solubility and dissolution behavior in vivo, depending upon a) the mineralogic makeup of the material, and b) the exposure route. For example, biodurable minerals such as asbestos and volcanic ash particles, whose health effects result because they dissolve very slowly in vivo, bleed off low levels of trace metals into the simulated lung fluids; these include metals such as Fe and Cr that are suspected by health scientists of contributing to the generation of reactive oxygen species and resulting DNA damage in vivo. In contrast, dry lake bed dusts and concrete-rich dusts are highly alkaline and bioreactive, and cause substantial pH increases and other chemical changes in the simulated body fluids. Many of the earth materials tested contain a variety of metals that can be quite soluble (bioaccessible), depending upon the material and the simulated body fluid composition. For example, due to their acidic pH and high chloride concentrations, simulated gastric fluids are most efficient at solubilizing metals such as Hg, Pb, Zn, and others that form strong chloride complexes; although these metals tend to partially reprecipitate in the near-neutral simulated intestinal fluids, complexes with organic ligands (i.e., amino and carboxylic acids) enhance their solubility. These metals are also quite soluble in near-neutral, protein-rich plasma-based fluids because they form strong complexes with the proteins. In contrast, metalloids that form oxyanion species (such as As, Cr, Mo, W) are commonly more soluble in near-neutral pH simulated lung fluids than in simulated gastric fluids.

V51D-0317 0830h POSTER

Structure of Carbonate Apatites Synthesized at 2-4 GPa

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Type A carbonate apatite (CAp), type A and B carbonated apatites, and complex type A-B CAp have been synthesized at 2-4 GPa and 1400-1500°C in a piston cylinder apparatus, and the accommodation of the carbonate ion studied at NTP using FTIR spectroscopy and X-ray structure analysis. Apatite compositions approximate to $Ca_{10}(PO_4)_{6-y}(CO_3)_{x+(3/2)y}(OH)_{2-2x}$, x = 0.0-0.7, y = 0.0-0.6. A new space group (P-3) and structure are reported for type A CAp with x = 0.5-1.0, y = 0.0. The type A carbonate ion is ordered along the apatite channel at z = 0.5; two of its oxygen atoms are close to the c-axis, and the plane of the ion is canted about 12°. This is the "closed" channel configuration,

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