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Island arc basalts (IAB) have been shown to have high Li/Yb relative to mid-ocean ridge basalts (MORB) and ocean island basalts (OIB). In addition, IAB have high K/Li relative to rare earth element (REE) fractionation. A positive correlation between Ba/Ti and Li/Yb has also been observed. Therefore, the generation of IAB must involve interaction with a component having the elemental abundances K, Ba>Li>Yb. Although some subducted sediments or altered oceanic crust may have this characteristic, the control of mica over K mobility in arcs is such that the affect of mica stability and breakdown on all of the above elements must be considered. We have performed mineral/fluid trace element partitioning experiments for two K-bearing micas, phlogopite and phengite, at 2.0 GPa, 900°C. Both K and Ba are strongly compatible in phlogopite (D_K=∼44, D_{Ba}=∼50) and phengite (D_K=∼32, D_{Ba}=∼21), Li is moderately compatible in phengite (D_{Li}=∼2), and Yb is somewhat incompatible in phlogopite (D_{Yb}=∼0.16). Although we do not have Yb partitioning data for phengite, biotite/muscovite partitioning data from natural rocks indicate that REEs are not significantly fractionated between the micas. Previous studies indicate that K mobility in arcs is controlled by mica stability in the subducting slab, and perhaps the overlying mantle wedge. Sediment dehydration and melting experiments have shown that K, Ba, and Li are released following mica breakdown with progressive heating. However, bulk sediment addition cannot explain Li/REE ratios or the extreme K/Li in some arc lavas. Our results indicate that mica (when present) will be the primary host of K, Ba, and Li in the eclogitic assemblage resulting from reactions in the crust and/or sediment layer as subduction progresses. Gradual breakdown of the micas with increasing pressure and temperature will contribute K, Ba, and to a lesser extent Li to the arc lava source, while contributing very little REE. The concentrations and relative fractionation of the REE are primarily determined by the degree and depth of melting in the mantle. The K/Li ratio may be useful as an indicator of relative mica contribution to the slab component, while the Li/Yb ratio may be useful as an indicator of slab vs. wedge contribution to arc lavas.

V51A-08 0945h

B, Cl, Li Variability in the Subducted Oceanic Mantle and in Antigorite-Breakdown Fluids: Implications for Fluid Processes and Light Element Recycling

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We present an inventory of B, Cl, Li in a set of ultramafites featuring the evolutionary stages of the subducted oceanic mantle, and in the fluid inclusions formed at antigorite breakdown. Samples correspond to: non-subducted serpentinites (Northern Apennine); high-pressure antigorite serpentinites (Western Alps; Betic Cordillera); high-pressure olivine-opx rocks (Betic Cordillera). Analyses of Cl, B, Li in the rock forming minerals indicate that the hydrous mantle is an important light element carrier. The estimated bulk-rock B and Cl decrease from oceanic (46.7 B; 729 ppm Cl) to antigorite serpentinites (20 ppm B; 221 ppm Cl) to olivine-opx rocks (9.4 ppm B; 45 ppm Cl), suggesting release of oceanic Cl and B in subduction fluids, likely without inputs from external sources. Li is less abundant in oceanic serpentinites (1.26 ppm) and such concentrations are still preserved in high-pressure serpentinites. High Li contents in the olivine-opx rocks (4.9 ppm bulk Li) suggest income from associated crustal rocks. LAM ICP-MS analyses of fluid inclusions representing the antigorite-breakdown fluid in olivine-opx rocks, enabled an estimate of the trace element composition of this fluid. The inclusion compositions yield maximum average $fluid/rock_{D_B}$ and $fluid/rock_{D_{Li}}$ of 11 and 17.8, respectively. Model calculations of the B and Cl loss form subducting serpentinite suggest $fluid/rock_{D_B}$ and $fluid/rock_{D_{Cl}}$ of about 15-30 and 30-60, respectively, and $fluid/rock_{D_B}$ / $fluid/rock_{D_{Cl}}$ < 1 (0.66-0.5). Cl thus preferentially partitions in fluids relative to B: the fluid B/Cl ratio progressively raises at increasing depths and temperature. Despite light element loss, appreciable B, Cl, Li are still stored in olivine-opx rocks beyond the antigorite stability. This permits a bulk storage of about 10 ppm B and 5 ppm Li, i.e. concentrations much higher than in normal mantle reservoirs. The oceanic mantle may thus retain B and Li deeper than the arc magma sources, potentially creating light element anomalies in the upper mantle.

V51B MCC: 3008 Friday 0800h

Fragmentation of Magma

Presiding: **L G Mastin,** U.S. Geological Survey**; H Gonnermann,** University of California, Berkeley

V51B-01 0800h

A fragmentation threshold for the initiation and cessation of explosive eruptions

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A fragmentation threshold for magma may be defined as the critical gas overpressure required to fragment volcanic materials when decompressed rapidly. There are several potential causes of pressure differentials between bubbles and melts in magma. In fact, bubble growth results itself from the action of bubble overpressure on the melt walls of the bubble. Perturbations of the pressure differential may additionally arise due to sudden decompression, flow pressure gradients in variably viscous magmas in conduits, or external influences such as landslides or gravitational dome collapse. Overcoming such a threshold provides a volcanic system with the possibility to change its behaviour from that of a relatively harmless effusive eruption into a potentially highly destructive explosive eruption The magnitude of the fragmentation threshold is likely to be a controlling factor in initiation and cessation of explosive eruptions. Pressure differentials commonly arise between the gas in bubbles and the ambient pressure of the surrounding melt. If the stress perturbations involved call for viscous strain rates higher than the relaxational strain rate (1/relaxation time) of the melt, brittle fragmentation may ensue. Here, we show results of fragmentation experiments at 850°C performed with volcanic rocks varying widely in porosity, permeability, crystallinity and chemical composition. Increasing porosity decreases the value of the fragmentation threshold. At high porosity values, the influence of permeability becomes increasingly important in defining the threshold. Chemical composition and temperature appear to have relatively minor effects. In contrast with existing models the present parameterization implies that the fragmentation threshold is proportional to the tensile strength of the porous magma in glassy response.

V51B-02 0815h

Shear-Induced Fragmentation in Silicic Volcanism

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Fragmentation of magma, containing abundant gas bubbles, is considered as the defining characteristic of explosive eruptions. When viscous stresses associated with the growth of bubbles and the flow of the ascending magma exceed the strength of the melt, it breaks into disconnected fragments suspended within an expanding gas phase. While repeated effusive and explosive eruptions for individual volcanoes are common, the dynamics governing the transition between explosive and effusive eruptions remain unclear. Magmas for both types of eruptions originate from sources with similar volatile content, yet effusive lavas erupt considerably more degassed than their explosive counterparts. Recent observations suggest that magma fragmentation may not be restricted to explosive eruptions and we find corroborating evidence of magma fragmentation, reannealing and elongation of fragments into flow banding from obsidians from Big Glass Mountain rhyolite dome, California. One mechanism for degassing during magma ascent is the generation of intermittent permeable fracture networks through non-explosive fragmentation near the conduit walls. To gain insight into the mechanics governing fragmentation in silicic volcanoes, we have developed a numerical model for magma ascent in the volcanic conduit. The ascending magma (melt + bubbles) is modelled as steady, isothermal flow of a single-phase liquid at constant mass flux in a cylindrical conduit of constant radius. We specify a pressure, number density of bubbles, and relaxed Newtonian melt viscosity at the base of the conduit and solve the joint problem of bubble growth and magma ascent. Rather than include the transition to fragmentation and flow of fragmented magma, we determine the ascent distance above the conduit entry at which magma fragmentation by viscous shear should first occur. The model is quasi-one-dimensional and for a given depth computes the radially varying vertical component of magma velocity. We show that shear-induced fragmentation can occur in both effusive and explosive eruptions and is consistent with the observed conditions of volcanic systems, with the degassed nature of effusive silicic lavas, and with textural observations at the outcrop to microscale. We suggest that it may be important for magma degassing and inhibition of explosive behavior. This implies that, contrary to conventional views, explosive volcanism is not an inevitable consequence of fragmentation.

V51B-03 0830h

Fault textures in a volcanic conduit

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Fault textures in the obsidian walls of a dissected rhyolitic conduit in Iceland record a history of fracture and healing in rising magma, and may represent fossilised hybrid and long-period volcanic earthquakes [1]. In this contribution we highlight the striking similarities between micro- and meso-scale fault textures in obsidian and those found in seismogenic tectonic faults [2,3]. The conduit walls contain networks of angular shear fractures, which are typically 0.1-2 m in length and filled with banded cataclasites generated by corner abrasion and wear on the fracture surfaces [2]. During continued flow of magma and shear deformation, these networks coalesce [4] and mature into near-planar shear bands parallel to the flow direction. Shear bands are up to 4.8 m long and several centimetres across, and slip is accommodated by distributed deformation in cohesive cataclasites and pseudotachylites. Due to the increasing cohesion of fracture-filling material during displacement, which is attributed to viscous and frictional heating, each fracture system heals, and thus has a limited seismogenic lifetime. The combination of localised slip and distributed flow textures are typical of the repetitive deformation sequences that are characteristic of seismic cycling [2,5]. Earthquakes occurring in highly-viscous magma and elsewhere in the crust are governed by similar physical processes. The material properties of the fractured medium, such as ductile-brittle behaviour, temperature-dependent viscosity and strength, are key to linking field observations and failure theory to recorded seismic events[1,6]. 1. Tuffen, H., Dingwell, D.B, Pinkerton H. (2003) Geology, in press. 2. Chester FM, Chester JS (1998) Tectonophysics 295:199-221. 3. Lin AM (1996) Eng Geol 43: 213-224. 4. Kilburn CRJ (2003) J Volcanol Geotherm Res 125:271-289. 5. Beeler NM et al. (2001) Bull Seis Soc Am 91:1797-1804. 6. Neuberg J, Tuffen H, Jolly A, Green D (2003) Abstract, Fall AGU 2003.

V51B-04 0845h

An Experimental View on the Vesiculation-Driven Fragmentation of Viscoelastic Media and its Implications for Plinian-Style Eruptions

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The exsolution and expansion of volatiles from magma are well acknowledged as the driving force for Plinian-style volcanic eruptions. However, it is still unclear whether during such activity magma fragments as a result of gas expansion within individual bubbles or the fast flow that expansion imposes upon it. Here we present the results of shock-tube experiments on the exsolution, expansion, and fragmentation of a gas-saturated viscoelastic medium, and their implications for Plinian-style eruptions.
Our sample material is a silicon polymer commercially named "Silly Putty©". We measure its viscoelasticity with a forced oscillation rheometer: the polymer is shear-thinning in the strain timescale 10^3-10^{-2} s, with its viscosity decreasing almost two orders of magnitude, and its relaxation time is of 0.2 s at 25°C. To evaluate the effect of argon exsolution on the viscosity of the sample we measure the rate of sinking of a steel rod into the sample under gas and atmospheric pressure. The results shows only a minor increase in viscosity as a consequence of sample compaction under gas pressure.
The experiments take place in a high-pressure Plexiglas chamber (volume ca. 10 cm^3, pressure up to 20 MPa) containing a sample of argon-saturated polymer. Sudden decompression of the chamber causes argon exsolution, bubble growth, expansion and flow of the polymer, and its fragmentation. A digital camcorder and pressure transducers record sample expansion and fragmentation and pressure profiles at the bottom and above the sample, respectively. Experimental variables include duration of the sample saturation phase, saturation pressure, and lubrication between sample and chamber. On decompression, the sample: 1) starts to exsolve gas and, after an interval of the order of 0.05 s, to expand; 2) accelerates for another 0.1 s; 3) reaches its maximum expansion after 1 s; 4) the now-foamed sample collapses in 10 s. During the second phase brittle cracks form in the top, fast-accelerating part of the sample, with geometries ranging from sub-horizontal in experiments with no lubricant to complex patterns in those with glycerin. The cracks rarely cut the whole sample into fragments, but mostly remain confined and, as the sample keeps on expanding, tend to heal. Using the video images we calculate the following parameters as a function of time: velocity of the sample front, porosity of the sample, and elongational strain rate: peak values are 1 ms^{-1}, 0.9, and 13 s^{-1}, respectively. From the length of sample that vesiculates and the saturation duration we estimate the diffusion coefficient of gas in the sample to be in the order of $5x10^{-9}$ m^2s^{-1}. Brittle fragmentation of the polymer implies a solid-like behavior. The measured peak elongational strain rate is of a time scale significantly shorter than the relaxation time of the polymer, which, during the acceleration phase, is thus forced to cross a rheological boundary. At this point the unrelaxed sample cannot flow any longer and, on overcoming the material tensile strength, velocity differentials are accommodated by fracturing. Note that after the acceleration phase the strain rate drops below 5 s^{-1} and the fractures in the now relaxed sample starts to heal. A process similar to the one described above has been suggested for the fragmentation of magma during Plinian-style eruptions and has received confirmation by numerical simulations. Our experiments support this mechanism and have the potential to further parameterize the process.

V51B-05 0900h

Fragmentation Efficiency via Fine Particle Analysis of Experimental Pyroclasts

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Internal overpressure can fragment porous volcanic rocks at pressure differentials mainly depending on the porosity. With increasing pressure, an increasingly effective generation of fine particles is expected. To date, experimental data on the fragmentation efficiency of natural multiphase samples has been absent. Knowledge of this fragmentation efficiency is however necessary for modelling explosive eruption behaviour and dome stability scenarios. To this end, a series of hot (850 °C) rapid-decompression experiments has been performed in a modified fragmentation bomb above the fragmentation threshold (i.e. the critical gas overpressure required to fragment volcanic materials when decompressed rapidly). We used cylindrical samples (d = 25 mm, l = 60 mm) with different porosity and known phenocryst content drilled from natural samples. The fragmentation depends on open porosity and permeability of the specific sample as these parameters are defining how much energy (the pressurised gas) can be stored inside the sample and how fast it can escape.
The artificially generated pyroclasts are sampled, dried and prepared for grain-size analysis and surface area measurements. Grain-size analysis includes dry sieving (wt.%) and wet laser particle sizing (vol.%). Grain size results are limited by the sample size and instrumental limitations (Coulter LS230, measuring range 0.375 - 2000 μm).
Laser particle Sizer results are cast for inclusion in a wt.%-grain size histogram. Preliminary results of experiments with dense sample from Unzen volcano (5 % average open porosity) at pressures up to twice as high as the sample's threshold (22.5 MPa) reveal a relatively similar grain size distribution with increasing pressure. The most abundant fraction (8<x<5.6 mm) represents 25 ± 2.5 wt.% of all particles.
The surface area is determined through Ar absorption after the BET method (Micromeritics Gemini). The evaluated results (m^2/g) are corrected by the known pre-fragmentation surface area and multiplied with the weight of the fine fraction to get the actual increase in surface area (m^2) in this size class. The m^2/g-results of the fine particles are up to 10 times higher than the value of the cylinders. The newly generated surface of the fine particles may exceed the total surface of the cylinders although representing only a small weight percentage. The newly generated surface seems to be correlated positively with pressure.

V51B-06 0915h

The role of magma porosity in explosive magma-water interaction

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We performed laboratory experimental studies to investigate magma-water mixing and triggering mechanisms in explosive magma water interaction. The experimental facility operates at pressures up to 200 MPa and temperatures up to 1200 /deg C. The goal of our experiments is to investigate magma-water mixing and the triggering of steam explosions. In contrast to previous studies, in our experiments magma-water mixing and vapor film collapse, prerequisites to induce the steam explosion, are self-triggered. That is, they are not induced by any external triggering signal. We keep parameters such as water/melt mass ratio, temperature, and confining pressure nearly constant, but the samples had two different grain sizes: a) a finely grounded powder (grain size approximately 0.05 mm, b) spatter grains 0.8 mm in size. Precautions were taken to make certain that the melt samples were completely dehydrated. The amount of injected water was kept as constant as possible, with a water/melt mass ratio around 0.4.The samples interact with water at a temperature of 800 or 900 /deg C and a confining pressure close to 8 MPa. The main qualitative experimental results are that: (1) No explosive melt-water interaction has been observed for the finely crushed (powder) samples; (2) The magma water interaction shows no obvious dependence on the melt temperature; (3) In the case of the spatter grain sample, data on particle size distribution indicate similar distributions for grains collected in the sample holder or in the gasket, indicating a possible partial melting of the grain ring only. The results of our experiments indicate that a pre-existing permeable/fragmented melt may be sufficient to initiate a phreato-magmatic eruption. Hydrodynamic premixing, a process inhibited by the large viscosity difference between the melt and water, may not be required to initiate an eruption. This is in contrast with experimental studies on pre-mixing of basaltic magma and water or peperites formation where hydrodynamic mixing appears to play an important role.

V51B-07 0930h

The role of turbulence in explosive magma-water mixing

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Juvenile tephra from explosive hydromagmatic eruptions differs from that of dry magmatic eruptions by its fine average grain size and highly variable vesicularity. These characteristics are generally interpreted to indicate that fragmentation, which occurs in dry magmas by bubble growth, is supplemented in hydromagmatic eruptions by quench-fracturing. Quench fragmentation is thought to accelerate heat transfer to water, driving violent steam expansion and increasing eruptive violence. Although some observed hydromagmatic events (e.g. at Surtsey) are indeed violent, others (e.g. quiescent entry of lava into the ocean at Kilauea) are not. We suggest that the violence of magma-water mixing and the grain size and dispersal of hydromagmatic tephras are controlled largely by the turbulence of magma-water mixing. At Surtsey, fine-grained, widely dispersed hydromagmatic tephras were produced primarily during continuous uprush events in which turbulent jets of magma and gas passed through shallow water (Thorarinsson, 1967). During Kilauea's current eruption, videos show generation of fine-grained tephras when turbulent jets of magma, steam, and seawater exited through skylights at the coastline. Turbulence intensity, or the fraction of total jet kinetic energy contained in fine-scale turbulent velocity oscillations, has long been known to control the scale of atomization in spray nozzles and the rate of heat transfer and chemical reaction in fuel injectors. We hypothesize that turbulence intensity also influences grain size and heat transfer rate in magma-water mixing, though such processes are complicated by boiling (in water) and quench fracturing (in magma). We are testing this hypothesis in experiments involving turbulent injection of water (a magma analog) into liquid nitrogen (a water analog). We also suggest that turbulent mixing influences relative proportions of magma and water in hydromagmatic eruptions. Empirical studies indicate that pressure-neutral turbulent jets ingest a mass of ambient fluid equal to the jet fluid by the time the jet has traveled several vent diameters from the orifice. In subaqueous magmatic jets, such a magma-water mass ratio of 1 would result in incomplete water vaporization and wet, sloppy deposits. Magma-water ratios of 3-5, which result in complete vaporization and maximal mechanical energy release, require a water depth that is roughly equal to or less than the vent diameter. In such shallow conditions, water would be entrained only in a narrow boundary layer at the jet margin by the time the jet exited the water body; additional mixing would take place in the atmosphere. These inferences are consistent with observations of continuous-uprush jets at Surtsey, which were surrounded by steam clouds for hundreds of meters above the water surface, but whose cores glowed red at night (Thorarinsson, 1967).

V51B-08 0945h

Numerical Simulations of Volcanic Eruptions Through a Crater Lake

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Results are presented from a series of numerical simulations of a layered column of magmatic fluids instantaneously released through a crater lake and into the atmosphere. The simulations are calculated from the adaptive mesh refinement two-dimensional multimaterial hydrodynamic computer code SAGE (Simple Adaptive Grid Eularian) developed at Los Alamos National Laboratory. The computational domain includes a conduit connected to a crater that is filled with water and atmosphere. The walls are either rigid or have a finite strength defined by the rigidity. The geometry of the conduit, crater (inner and outer walls) are scaled according to the parameters estimated for Mt. Ruapehu volcano, N.Z. The crater lake is 480 m wide, 138 m deep with a base width of 50 m that corresponds to the width of the conduit. The lake temperature is 40-60C. The conduit is layered with an upper steam rich layer at 750C this is underlain by andesitic magma at 950C. The thickness of the steam rich layer varies from 10m to 200m and the pressure inside the conduit ranges from 0.5-5.0 MPa. The fluids inside the conduit are release instantaneously into the crater lake. The following sequence of events is observed during the release of the pressurized steam-rich layer on a time scale on the order of 10s of seconds: a pressure wave is released into the water and propagates through the lake and into the atmosphere and causes a series of complex reflections in the lake. As magmatic fluid flows out of the conduit into the lake, the lake level rises to accommodate the expanding fluid. The amount that the lake level rises depends on the volume and pressure of the upper gas rich layer. We show that at a pressure of at least 1.0 MPa and a volumetric ratio of lake

water to magmatic gas of less than 1.1 are required to raise the lake level on the order of 1-10s meters. Such water levels may allow water to drain down the outer crater walls. The water level begins to drop once the expanding fluid looses sufficient heat to the lake water. Lake water that was pushed up along the inner crater walls begins to drain back down and into the conduit. The downward motion of the lake water and upward movement of steam collide to generate a pressure wave in the atmosphere. This sequence of events though generated from a simple eruption scenario, may be one of the mechanisms for lahar generation (Mt. Ruapehu volcano, N.Z.), updoming of the sea or lake surface prior to eruptions (Ritter Island, Papua N.G., Mt. Ruapehu volcano, N.Z.), and rapid evaporation of crater lakes observed during crater lake eruptions (Mt. Spurr, Alaska). The sequence of event becomes more complex when the walls deform, magma rises through the crater and a thermal source is used to pressurize the conduit prior to eruption. All results will be presented in a series of parametric animations.

V51C MCC: Level 1 Friday 0830h

U-Series in Continental Environments: Soils, Rivers, and Groundwaters II Posters *(joint with H)*

Presiding: **B Bourdon,** Institut de Physique du Globe de Paris**; F Chabaux,** Université de Strasbourg**; D Porcelli,** University of Oxford

V51C-0303 0830h POSTER

Interest of 238U-234U-226Ra Disequilibrium for Tracing Groundwater Inputs Into Surface Waters: A Case Study

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Characterization of deep water inputs into surface waters requires geochemical tracers that develop different signatures in surface and ground waters. It has been suggested that U activity ratios could play such a role (e.g. Riotte et Chabaux 1999). Here we propose to test this hypothesis in the case of the Lauter stream (East France-West Germany), a stream that drains sandstone of the Bundsandstein sequence, in which several superimposed and more or less independent aquifers are developed. Major elements, trace elements, Sr isotope ratio and 238U-234U-226Ra disequilibrium have been analysed in the dissolved load of water samples collected in the Lauter stream and in the different groundwaters of the sandstone formations. The data certainly give the first convincing demonstration of the usefulness of U activity ratios in surface waters to quantify the influence of deep waters upon surface waters. The data point out that, in the specific case of the Lauter stream, more than 50% of the total dissolved load carried by the stream is supplied by deep waters. This contribution significantly modifies the 226Ra/238U activity ratio, which in turn suggests that 238U-226Ra disequilibria could also be helpful for discriminating in the global chemical fluxes carried by rivers, those representative of surface weathering processes. Overall these results highlight (1) the necessity to distinguish surface weathering fluxes from deeper ones in order to establish realistic weathering budgets at the scale of a watershed from chemical analyses of river waters and (2) the potential of 238U-234U-226Ra disequilibria to perform such distinction. Riotte et Chabaux (1999) Geochim. Cosmochim. Acta 63 1263-1275

V51C-0304 0830h POSTER

^{238}U-Series in Fe Oxy/Hydroxides by LA-MC-ICP-MS, New Insights Into Weathering Geochronology

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The establishment of a geochronological framework for weathering processes is essential for an understanding of the evolution of the regolith and its dynamics. However, there are few robust answers regarding the absolute age of weathering and its rates. Nowadays, ^{40}Ar/^{39}Ar analysis of Mn-Oxides (cryptomelane) and K-bearing secondary sulphates have provided one of the few generally reliable chronometers (e.g. 1), but is restricted to high-K secondary phases. This work presents a different approach to obtain geochronological information from weathering minerals, namely measurement of ^{238}U-series disequilibria in authigenic Fe oxy/hydroxides. These may be potentially useful recorders of weathering processes as they commonly occur as weathering products and have high affinity towards dissolved uranyl complexes. Furthermore, U-Th fractionation during weathering has been extensively reported [2], effectively resetting the U/^{230}Th geochronometer. LA-MC-ICP-MS facilitates in situ measurement of ^{238}U-series disequilibria in authigenic microcrystalline iron oxy/hydroxides (precipitated between cracks and veins in partially and heavily weathered chlorite-muscovite schist) and pisoliths (ferruginous concretions). Contrary to previous studies [e.g. 3], in situ measurement of ^{238}U-nuclides enables selective analysis or iron oxy/hydroxides phases, minimizes contributions from allogenic phases and, reduces the need of mathematical corrections to obtain the activity ratios for the authigenic phase [4, 5]. The results suggest that supergene iron oxy/hydroxides are good recorders of weathering processes; they precipitate during the early stages of weathering, reflect the U-isotopic composition of the groundwater, appear to act as closed-systems in weathering conservative environments, and behave in a predictable fashion when subjected to intense weathering and leaching conditions. The ^{230}Th-ages of the iron oxy/hydroxides indicate that the timing and intensity of weathering appears to be largely controlled by global climatic changes, suggesting that weathering rates have not been constant during the last 300 ka in Northern Australia. References: 1 P.M. Vasconcelos. Annual Review in Earth and Planetary Sciences 27(1), 183-229, (1999) 2 M. Ivanovich and R.S. Harmon, Uranium-series disequilibrium : applications to earth, marine, and environmental science, xxxiv, 910 pp., Oxford University Press, Oxford, (1992) 3 S.A. Short, R.T. Lowson, J. Ellis and D.M. Price. Geochimica et Cosmochimica Acta 53, 1379-1389, (1989) 4 K.R. Ludwig and D.M. Titterington. Geochimica et Cosmochimica Acta 58(22), 5031-5042, (1994) 5 Luo, S. and T. L. Ku. Geochimica et Cosmochimica Acta 55(2): 555-564. (1991)

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Origin of the dissolved U-Sr fluxes in the Himalayan rivers: cases of the Indus, Ganges and Brahmaputra

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The rivers draining the Himalaya are recognised as major contributors to the dissolved riverine flux to the oceans, with a non-negligible effect on the global budget of elements such as Sr and U. The precise characterisation of the different sources contributing to these fluxes is important and has to be done to model correctly the Himalayan river chemical flux variations through time, in response to climatic or tectonic variations and to better constrain the impact of these rivers on the U and Sr oceanic budget. The recent study of the Ganges watershed has shown the potential of the U-Sr combined isotopic analyses to reach this objective (Chabaux et al., 2001). We propose to extend this approach for the two other main Himalayan rivers: the Brahmaputra and the Indus. Our results show that the U and Sr fluxes carried by the Brahmaputra are not only controlled by the Himalayan end-member identified during the study of the Ganges watershed, but also by a chemical flux coming from the Tibetan plateau and another one specific of the plain formations. These two latter fluxes contribute to the U and Sr dissolved budget of the Brahmaputra during the dry season, and at different intensities for these two elements. During the monsoon, their impact seems to be negligible compared to the flux coming from the Himalayan chain. As a first approximation therefore, the annual hydrological cycle of the Brahmaputra river would have a U-Sr systematics very close to that of the Ganges river. By contrast, for the Indus River, in addition to the Himalyan flux, U and Sr dissolved budget is significantly affected by chemical fluxes from the Tibetan plateau, the plain and also from the West Pakistan Fold belt. The input of the Punjab river, the main Indus tributary that strongly influences the U-Sr budgets, on the Indus can be explained in terms of mixing between the Himalayan and the plain end members. These results will be used to constrain the response of U and Sr fluxes of the Himalayan river system to climatic variations and to discuss the impact of these variations on U and Sr oceanic budgets. Chabaux F., Riotte J., Clauer N. and France-Lanord C. (2001) GCA 65(19), 3201-3217

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Controls on d234U in surface waters of the South Island of New Zealand

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The development of new proxies with which to assess the interconnection of climate and continental weathering is important because of the role of silicate weathering in the long-term carbon cycle. A potential proxy of both modern and past weathering regimes is the U isotope ratio 234U/238U (expressed as d234U). River water is nearly always enriched in 234U, due to release of alpha-recoil mobilised 234U from continental rocks. High d234U values may be expected in areas where this recoil 234U can build up, or where fresh mineral surfaces are continually being exposed. The South Island of New Zealand is an ideal place to investigate the dominant controls on riverine d234U since it has a wide range of uplift rates and climate environments. We have analysed U concentration and d234U in more than 30 surface-water samples by MC-ICP-MS. These samples include rivers, lakes, groundwater and glacial melt. The concentration of U in both glacial ice and ground waters is low, so the dominant source of U in surface waters is from weathering. The d234U values are extremely variable (68 to > 3600) and display some of the highest values that have been observed. The bedrock chemistry is reasonably uniform so this range in d234U is not a function of changing lithology. The d234U values are, therefore, controlled only by the production rate of mobile 234U and its susceptibility to removal by river water. A clear positive relationship between river d234U and uplift rates is observed, suggesting that physical weathering is an important control on d234U. For instance, the samples with the highest d234U values (2800-3600) are from the zone of maximum uplift on the dry east coast, whereas low d234U values (68-80) are observed further south where there is virtually no vertical uplift. Rainfall also plays a clear role as demonstrated by high rainfall on the west coast which causes lower riverine d234U when alpha-recoil mobilised 234U is quickly washed away. Both the U concentration and d234U are also altered by the lacustrine processes, particularly where glacial silt is present. Observed changes of d234U with time have been linked to past climate in a number of speleothem records. This study provides some support for the use of d234U as a proxy for rainfall, but also shows that d234U is extremely dependent on the rate of physical erosion.

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Do $(^{234}U)/(^{238}U)_o$ Variations in Speleothems Record Paleohydrologic Flux?

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Analysis of U-series disequilibria in speleothems not only provides a means of accurate chronology but also a record of $(^{234}U)/(^{238}U)$ variations in the source groundwaters through time. We present high precision TIMS data from speleothems and drip waters from Fogelpole Cave in Southern Illinois and suggest that