Melt Inclusion Workshop Posters
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Chelsea Allison
Cornell University

Title: Evidence for exsolved fluid at depth from melt inclusions in a basaltic sub-Plinian eruption at Sunset Crater volcano

Co-PIs: Kurt Roggensack, Arizona State University, and Amanda B. Clarke, Arizona State University

Abstract

Sunset Crater volcano (AZ, USA) is an alkali basalt scoria cone that produced a sub-Plinian eruption ca. 1085 AD. Primary melt inclusions (MIs) in free olivine crystals from the tephra deposit have dissolved volatile contents of 0.5 wt% to 1.5 wt% H_2O and 1,200 ppm to 3,000 ppm CO_2. MI vapor bubbles were measured by Raman spectroscopy, calibrated with synthetic CO_2 inclusions, to determine total CO_2 content. Calculations constrain bubble volume from post-entrapment MI shrinkage and crystallization to <3 vol% in these samples. Approximately 1/3 of MIs with no signs of decrepitation contain larger bubbles that likely include co-entrapped exsolved fluid. Total MI CO_2 contents (dissolved CO_2 plus bubble) reach 6,500 ppm. Large MI bubbles contain the most CO_2, consistent with co-entrapped fluid. The CO_2 dissolved in the magma at MI entrapment ranges up to ~4500 ppm, indicating depths of ~10 km to 18 km. The co-entrapped vapor suggests a bubbly magma and significant overpressure at depth, which likely drove rapid magma ascent to produce the sub-Plinian eruption. Characterization of MI vapor bubbles not only yields important information about total volatile contents of magmas, but also provides physical constraints on eruptive processes.

Anna Barth
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Title: Control of magma decompression rate on the explosivity of basaltic eruptions

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Abstract

Magma decompression rate plays a crucial role in modulating the dynamics of explosive basaltic eruptions. This control is imparted through the kinetics of crystallization and bubble nucleation, rheological changes, and dynamics of the multiphase flow. We explore whether the transition from VEI 2 to 3 intensity could be the result of an increase in magma decompression rate. To constrain decompression rate, we exploit the incomplete diffusive re-equilibration of water through olivine. In order to isolate the effects of decompression rate from other controls on eruption style, we focus on two eruptions at the same volcano; the 1992 (VEI 3) and 1995 (VEI 2) eruptions of Cerro Negro, Nicaragua.

Olivine-hosted melt inclusions (MIs) show a negative correlation between MI size and diffusive water loss, as predicted for diffusive re-equilibration. We develop a 1D numerical model of diffusion from the MI through the host olivine, coupled with a degassing model in the magma, and find that the 1995 olivines ascended five times slower on average than those from the 1992 eruption. MIs from both eruptions extend to comparable maximum H_2O and CO_2 contents (~ 4.75 wt.% H_2O, ~ 600 ppm CO_2), suggesting similar magma source conditions.

The largest uncertainty in our modelling comes from the six order of magnitude range in hydrogen diffusivity from the literature. Some of this variation is due to effects of anisotropic diffusion, while the rest is likely due to a range in olivine composition, particularly Fe content. To better constrain the diffusivity relevant to our system, we perform dehydration experiments on oriented cuboids of Cerro Negro olivine. We find diffusivities intermediate between those measured on natural olivine from San Carlos and Kilauea Iki and the fast 'proton-polaron' mechanism. Using our diffusivity, we find that the 1992 magma ascended from 15 km in ~3 hours, while it took the 1995 magma ~15 hours.

Antoine Bracco Gartner
VU University Amsterdam

Title: Pliocene–Quaternary intraplate magmatism in Anatolia: Insights from melt inclusions and mineralogy

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Abstract

Pliocene–Quaternary intraplate magmatism occurs in different parts of Anatolia with contrasting tectonic regimes, related to the continental collision of Africa and Arabia with the Eurasian plate. We present a detailed study of olivine-hosted melt inclusions (MI) and (near-)liquidus phases (olivine phenocrysts and chromian spinel inclusions) in mafic alkaline lavas from volcanic centers in western (Kula), southern-central (Ceyhan-Osmaniye) and southeastern Anatolia (Karacadağ), aimed at exploring the make-up and origin of intraplate magmatism within these geodynamically distinct settings.

Compositional variations in coexisting olivine (Fo, CaO, NiO), spinel (Cr#, Mg#) and MI (major and trace elements) reveal heterogeneity in primary melts and contributions of compositionally distinct end-members in the magma sources of each of these Anatolian volcanic centers. Estimated P–T conditions of primary melt generation in mantle domains are not uniform and, in agreement with the geochemical signatures of the melts, substantiate marked differences between sources and melting regimes. Our results suggest that interplay between upwelling asthenospheric mantle, facilitated by extensional processes, and spatially variable overlying lithospheric mantle created the compositional spectrum of intraplate-type primary melts throughout Anatolia.

Damaris Butters
University of Bristol

Title: Zircon-Hosted Melt Inclusions in Porphyry Systems

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Brian Tattitch, University of Bristol, UK
Cam McCuaig, BHP Geoscience Centre of Excellence, Perth, Australia
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Abstract

Porphyry copper deposits (PCDs) are magmatically-derived geochemical anomalies that concentrate economic quantities of metals in the crust. It is generally agreed that PCD formation requires highly fractionated hydrous arc magmas, oxidised conditions and the exsolution of magmatic volatile phases (MVPs) which extract Cl, S and metals from the magma, leading to ore precipitation. Corrosive magmatic-hydrothermal fluids associated with porphyry intrusions frequently destroy primary mineral assemblages and alter whole-rock compositions. This has resulted in a significant gap in our understanding of the metal and volatile budgets of the parental porphyry magmas prior to MVP exsolution.

Zircon is ubiquitous in evolved porphyry intrusions, and with its refractory nature and insolubility in acidic fluids, it makes an ideal host for melt inclusions. We have recently identified abundant glassy and crystalline melt inclusions (1-200μm) in zircons from porphyry intrusions in Chile. We propose that melt inclusions in zircon represent vestiges of the porphyry melt and may be analysed to establish the initial magmatic volatile contents, chemistry and intensive parameters of these parental magmas. To our knowledge, there are currently no publications on the use of zircon-hosted melt inclusions in the context of PCDs, but these inclusions are promising recorders of processes occurring during the magmatic stages of PCD evolution.

Babita Rani Choudhary
Guangzhou Institute of Geochemistry, China

Title: Magma composition and role of volatile degassing in Deccan Large Igneous Province: A melt inclusion approach

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Abstract

The Deccan LIP constitutes one of Earth's largest continental flood basalt provinces (Glišović and Forte, 2017). The inclusions are crystalline, glassy, with or without a shrinkage bubble, usually distorted, due to pressure changes inside the inclusion (Wallace et al. 2015). Inclusions are enriched in TiO_2 (3.68 to 0.08 wt%) and FeO (18.3 to 2.63 wt%). SiO_2 ranges from 43.4-66.8 wt%. Al_2O_3 ranges from 9.7-22.4wt % and MgO 18.3-1.6. EPMA measurements demonstrated the presence of daughter crystals, such as magnetite and titanomagnetite. Volatile concentrations were measured by FTIR, show a wide variable range of volatiles (up to 2 wt% H_2Ototal and 1808 ppm CO_2). Compositions are affected by diffusion, e.g. precipitation of host, resulting in the high Al_2O_3 .Melt inclusions showed evolved melt with the aggregated crystals indicating that formation of these Fe-Ti oxides has occurred in an aqueous condition. Daughter mineral assemblages (titanomagnetite, and magnetite) promotes the diffusion of hydrogen.
Glišović P and Alessandro M. Forte (2017) Science 355, 613–616
Wallace et al. (2015) American Mineralogy 100, 787-794

Nicolas Cluzel
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Title: Dukono, the predominant source of volcanic degassing in Indonesia, sustained by a depleted Indian-MORB

Abstract

Located on Halmahera island, Dukono is among the least known volcanoes in Indonesia. A compilation of the rare available reports indicates that this remote and hardly accessible volcano has been regularly in eruption since 1933, and has undergone nearly continuous eruptive manifestation over the last decade. The first study of its gas emissions, presented in this work, highlights a huge magmatic volatile contribution into the atmosphere, with an estimated annual output of about 290 kt of SO_2, 5000 kt of H_2O, 88 kt of CO_2, 5 kt of H_2S and 7 kt of H_2. Assuming these figures are representative of the long-term continuous eruptive activity, then Dukono is the current most prominent volcanic gas discharge point in Indonesia and ranks among the top-ten volcanic SO_2 sources on earth. Analyses of major, trace and volatiles elements from melt inclusions especially indicates that this voluminous degassing output from Dukono is sustained by a depleted Indian-MORB (I-MORB) mantle source. This latter is currently undergoing lateral pressure from the steepening of the subducted slab, the downward force from the Philippine Sea plate and the westward motion of a continental fragments along the Sorong fault, leading to high fluid fluxes to the surface. Over the course of Dukono eruptive activity, the magma reservoir has changed from a less differentiated source that fed the past voluminous lava flows to a more evolved melt that sustained the current ongoing explosive activity.

Lydéric France
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Title: Oldoinyo Lengai natrocarbonatite derives from classical calciocarbonatite: a melt inclusion study

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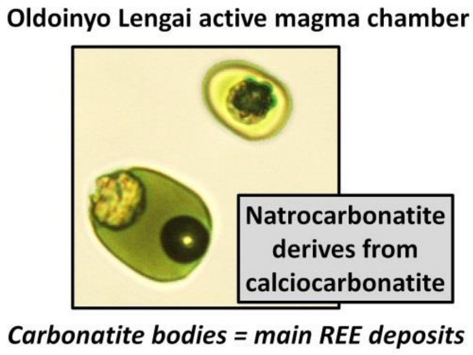
Abstract

Carbonatites are rare magmas containing almost no silica; their igneous counterparts represent the main rare earth element deposits in production. No consensus exists on their origin, genesis and evolution. Oldoinyo Lengai (Tanzania) is the only active carbonatite volcano, but the alkali-rich natrocarbonatites it erupts are unique among the >500 reported fossil carbonatite occurrences. Here, we use exceptional 3-phase melt inclusions from cognate cumulates—sampling the active Oldoinyo Lengai magma chamber during the 2007–08 sub-Plinian explosive eruption—to track the carbonatite presence within the plumbing system, and to eventually quantify its composition at depth. We show that although natrocarbonatites are emitted at the Oldoinyo Lengai summit, more classical calciocarbonatites are present at magma chamber depth, consistent with rare natrocarbonatites deriving from calciocarbonatites by further magma differentiation. We present the first direct measurements of major and trace element partition coefficients between natural coexisting carbonate and silicate melts. Partitioning behaviour and recent experiments support our conclusion that natrocarbonatites derive from calciocarbonatites by fractionating Ca-rich, Na-poor phases. Natrocarbonatites are highly unstable at surface conditions, and were likely erupted (but not preserved) in association with fossil calciocarbonatites worldwide, and Oldoinyo Lengai can be considered as representative of other carbonatite systems.



Marion Gaborieau
Laboratoire Magmas et Volcans

Title: Iron isotope fractionation in olivine-hosted melt inclusions as an indicator of mantle oxygen fugacity

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Abstract

Many studies have demonstrated that arc basalts are more oxidized (QFM -0.5 to +4) than MORBs (QFM-1.2 to ~ QFM; [1-6]). However, the oxidation state of the sub-arc mantle is still debated. On the one hand Kelley and Cottrell [2, 3] suggest that variations in the Fe3+/FeTot ratio measured in basaltic glasses and olivine-hosted melt inclusions from mid-ocean ridges and arcs could be explained by the sub-arc mantle being more oxidized than the mantle beneath ridges. On the other hand, Mallmann and O'Neill [7] and Lee et al. [8] proposed the use of other fO2 proxies, namely V/Sc and Zn/FeTot ratios in lavas and suggested that the oxidation state of the MORB mantle could not be distinguished from that of the mantle wedge. In a study of synthetic glasses ranging from basaltic to rhyolitic compositions, Dauphas et al. [9] have demonstrated that iron isotope fractionation is mainly controlled by redox (Fe3+/FeTot) and polymerization of silicate melts. In the present study and for the first time, iron isotopic compositions (56Fe/54Fe) were measured by SIMS in olivine-hosted melt inclusions from various arc, OIB and MORB localities. The results obtained with this technique, along with Fe3+/FeTot ratios obtained by XANES on the same set of melt inclusions, are used to constrain the oxidation state of primary magmas formed in these different geological settings and their mantle source.

[1] Pichavant & Macdonald (2007) Contrib. Mineral. Petrol. 154, 535-558. [2] Kelley & Cottrell (2009) Science 325, 605-607. [3] Kelley & Cottrell (2012) Earth Planet. Sci. Lett. 329–330, 109–121. [4] Christie et al. (1986) Earth Planet. Sci. Lett. 19, 397–411. [5] Bézos & Humler (2005) Geochim. Cosmochim. Acta 69, 711–725. [6] Cottrell & Kelley (2011) Earth Planet. Sci. Lett. 305, 270–282. [7] Mallmann & O'Neill (2009) J. Petrol. 50, 1765-1794. [8] Lee et al. (2010) Nature 468, 681-684. [9] Dauphas et al. (2014) Earth Planet. Sci. Lett. 398, 127–140.

Glenn Gaetani
Woods Hole Oceanographic Institution

Title: Determining magma ascent rates from diffusive D/H fractionation in olivine-hosted melt inclusions

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Abstract

The depths at which magmas are stored, their pre-eruptive volatile contents, the nature of degassing (i.e. open- versus closed-system), and the rates at which they ascend to the Earth's surface are interrelated, and exert important controls on the dynamics of volcanic eruptions. Of these variables, magma ascent rates are particularly difficult to quantify due to a lack of geospeedometers applicable to processes occurring on timescales ranging from hours to days. We developed a new approach to determining ascent rates on the basis of D/H fractionation associated with diffusive H2O loss from olivine-hosted melt inclusions (MIs). During ascent, the host magma degasses which, in turn, drives diffusive loss of H from MIs. Preferential loss of H – relative to the more slowly diffusing D – leads to increasing D/H with decreasing H2O concentration in the MI. The extent of diffusive H2O loss and D/H fractionation is primarily a reflection of ascent time, the nature of degassing, and melt inclusion size. This approach was used to determine the ascent rate for hyaloclastite from Hut Point Peninsula, Antarctica. All inclusions are glassy and contain vapor bubbles. Total CO2 was determined by summing CO2 in the included glass and in the vapor bubble (VB). The volumes of MIs and VBs were determined by X-ray microtomography, and the density of CO2 within each VB was determined using Raman spectroscopy. The included glass was analyzed for volatiles and D/H by secondary ion mass spectrometry. Entrapment pressures calculated on the basis of total CO2 and maximum H2O using the MagmaSat solubility model [1] indicate a depth of origin of ~24 km – in good agreement with the seismically determined depth of the Moho beneath Ross Island [2]. Results from finite difference modeling are consistent with closed system degassing and an average ascent rate of ~0.5 – 2.0 m/s. References: [1] Ghiorso and Gualda (2015) Cont Miner Pet 169; [2] Finotello et al. (2011) Geophys J Int 185, 85-92.

Michael Garcia
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Title: Assessing Historical Parental Magma Compositional Variations at Kīlauea Vvolcano, Hawaii

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Two hundred years of magmatic history are preserved by lava and tephra from Kilauea's historical summit eruptions. Whole-rock data show large and systematic compositional and isotopic variations during the last two centuries from 1820 to 1924, when the summit suddenly and violently collapsed. Thereafter, a reversed geochemical trend has continued for 80 years, including the 35-year-old Puu `O`o eruption. Melt inclusions in relatively primitive olivine (forsterite, Fo 85-90) were examined to determine the cause of these trends (e.g, magma mixing or systematic parental magma changes). These rapidly-quenched samples show minimal post-entrapment re-equilibation with host olivine. The melt inclusions from a single lava trap a remarkable range in major and trace element compositions, much larger than recorded in the erupted lava during the last 200 years, although inclusions within individual olivines show a limited range. The range of melt inclusion compositions in high Fo olivine record primary magmatic variation, especially for major and trace element ratios (e.g., CaO/Al2O3, Nb/Y, La/Yb). These results indicate that magma supplying Kilauea changes rapidly (over less than a decade) and that its source has small-scale mantle heterogeneities. These short-term magma compositional variations are buffered by the summit magma chamber but preserved in melt inclusions from high Fo olivine. The rapid and overall systematic nature of these temporal geochemical variations indicate that summit eruptions are fed from a simple, relatively small reservoir that is being continuously fluxed with new, mantle-derived magma. The rate of compositional variation during the last two hundred years is directly correlated with magma-supply rate and the estimated degree of melting. Magma supply rate and the degree of melting are probably controlled by the scale of source heterogeneity within the Hawaiian plume.

Emma Gatti
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Title: δD Variations In Olivine-hosted Melt Inclusions Due to Post-Entrapment Processes: A Case Study From Baffin Island Picrites

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Abstract

Water concentrations and δD values obtained from olivine-hosted melt inclusions are routinely used to estimate the amount of H2O and the δD of the upper mantle. However, olivine-hosted melt inclusions do not necessarily retain a record of the original H2O conditions, due to post-entrapment processe such as diffusive loss or gain of H+ (Gaetani et al., 2012, Bucholz et al., 2013). Recently, new analyses of melt inclusions from Baffin Island (Hallis et al., 2015) reported H2O contents ranging from 576 to 1964 ppm and light δD values between -97‰ and -218‰ , together with a negative H2O-δD correlation. Such correlation was interpreted as an indication that the inclusions dehydrated before the eruption, either via H+ migration from the melt to the olivine, or via degassing. The most depleated value (-218‰) was suggested to be the most indicative of the isotopic composition of H in the mantle, and interpreted as the indication of the presence of an heterogenous mantle tapping a deep, primitive, undegassed source. We analysed melt inclusions and their host olivines from two samples from the same locality as presented in Hallis et al. We report H2O content between 530 and 1243 ppm and δD values between -96 and -112‰ for the melt inclusions, and olivine H2O content between 1 to 17 ppm, consistent with analyses of olivines from MORBs-type basalts. Our data show no negative correlation between water content and δD, althought they are consistent with the majority of the non-depleted δD and low H2O contents reported in Hallis et al. We cannot confirm nor refute the extremely light δD value presented by Hallis et al., however we discuss the possibility, based on results from

hydration experiments, that the light δD values and the negative H2O-δD correlation observed by Hallis et al. could have been caused either by pre-eruptive hydration-induced H+ diffusion, or by post-eruptive molecular water diffusion, due to hydration of the olivines by meteoric water.

Felix Genske
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Title: Chemical and isotopic compositions of melt inclusions from the Faroe Islands

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Abstract

Melting of the proto-Iceland Plume produced the intra-plate lavas of the Faroe Islands (1-3). The basaltic rocks from the Faroe Islands follow a liquid line of descent (Ol-chromite-Cpx-Plag) and are not modified by crustal assimilation during magma evolution. The middle lava series, the so-called Malinstindur Formation, contains picrite flows with up to 50% olivine (Ol), and thus formed by accumulation of Ol (3). Whole-rock and Ol-hosted melt inclusions (MI) from this formation along with samples from the younger Enni Formation were analysed for their major element, trace element and Sr isotope composition. Melt inclusions are influenced by post-entrapment crystallisation of Cpx and chromite. However, their comparatively depleted, but homogenous trace-element compositions overlap those of the host lavas, specifically those of the 'low-Ti' group (3, 4).

Strontium isotope compositions of MI in Ol, which have been grouped by their Fo contents (Fo93-85, in 1 mol. % Fo bins), reveal large variations within this single lava flow. This variation in 87Sr/86Sr increases with decreasing Fo, suggesting progressive melt mixing during magmatic differentiation. The total variation in Sr isotope ratios in the MI population covers 50 % of the variation recorded in the erupted lavas but is slightly biased towards the radiogenic end of the spectrum.

1 Gariépy et al. 1983. EPSL 63. 2 Holm et al. 2001. Chem.Geol. 178. 3 Søager & Holm 2011. Chem.Geol. 280. 4 Millett et al. 2017. Lithos 286-287.

Ery Hughes
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Title: Reconstructing initial CO2 contents of magmas using carbon isotopes in melt inclusions

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Abstract

Melt inclusions (MIs) are often used to estimate the volatile evolution of magmas as they ascend and degas. Volatiles with high solubility (H2O) and/or low (below saturation) concentrations (S and Cl), remain dissolved to low pressures. Hence, there is plenty of opportunity for MI formation during ascent. In contrast, CO2 is less soluble, and some natural concentrations are high enough to saturate at much greater depths, well before MIs are captured. This early stage of volatile loss is not recorded, leading to an underestimate of the importance of CO2 in the system. Even when the primitive CO2 content is captured there are problems of bubble formation post-entrapment.

As MIs fail to capture the early degassing history, an alternative way to estimate initial CO2 concentrations is using carbon isotopes. Carbon isotopically fractionates during degassing, resulting in an

isotopically heavier fluid (13C-rich) and a light melt (12C-rich), where the magnitude of fractionation is controlled by the fractionation factor (Δ). Based on new experimental data, we derived a model for Δ which varies with pressure and XCO2, leading to extreme values of Δ up to 16 ‰, in contrast to previous data which had a constant Δ of 2 – 4 ‰. We analysed the CO2, H2O, and δ13C of MIs from Rangitoto, New Zealand, and Etna, Italy, and model their evolution during degassing to estimate their initial CO2 contents. We assess the effect of bubble formation on the δ13C of MIs and its impact on δ13C modelling.

Alexander Iveson
Durham University

Title: Tracing fluid variations across the Kamchatka arc: melt inclusion volatile contents and B isotopes

Co-authors: M.C.S. Humphreys, I.P. Savov, T.G. Chruikova, C.G. Macpherson

Abstract

We present a new suite of volatile and trace element contents (e.g. H2O, CO2, S, Cl, F, Li, Be, B, Nb, REEs), and δ11B signatures of primitive olivine-hosted melt inclusions from 10 volcanoes of the Kamchatka arc. The volcanic centres investigated span the total length and width of the arc, and encompass the Eastern Volcanic Front (EVF), Central Kamchatka Depression (CKD), and the extreme back-arc Sredinny Ridge (SR). We also present the first primitive melt inclusion data for Bakening (up to 4 wt.% H2O, >2000 ppm CO2, >2500 ppm S, and 1300 ppm Cl) and Shiveluch volcanoes, and in combination these samples provide us with robust spatial constraints to track variations in subduction zone fluid chemistry and fluxes between the distinct tectonic locations.

The euhedral and naturally glassy melt inclusions are primarily derived from Fo90-75 olivine crystals extracted from rapidly quenched mafic scoria, minimising the potential for post-entrapment modification. However, a suite of crystallised inclusions from lava flows were rehomogenised using either an internally heated pressure vessel or a Vernadsky heating stage. Geochemical analyses of the inclusions were conducted through a combination of EPMA, SIMS, Raman, and LA-ICP-MS techniques.

Tatsuhiko Kawamoto
Kyoto University, Japan

Title: Na/K and S/H2O ratios of fluid inclusions in Pinatubo harzburgite xenoliths

Co-authors: Kimura, J. -I., Cang, Q. (JAMSTEC), Yoshikawa, M. (Hiroshima Univ), Okuno, M. (Fukuoka Univ), Kobayashi, T. (Kagoshima Univ)

Fluid inclusions in the Pinatubo harzburgite xenoliths have compositions of Na73K27 according to LA-ICP-MS. This is more K-rich than those of aqueous fluid components in the Mariana Trough basalts (Na82K12, Stolper & Newman 1995, EPSL) and H2O-rich slab components in Mt. Shasta basalts (Na77K23, Grove et al. 2002, CMP), and between two H2O-rich components estimated from olivine melt inclusions from Mt. Shasta (Na70K30 of melt or supercritical fluids components and Na87K12 of aqueous fluids components, Le Voyer et al. 2010, J Petrol).

Sulfate ions and gypsum and/or anhydrite crystals were found in the Pinatubo fluid inclusions. Sulfur contents in the fluid inclusions are <5mg S in 1g water, which are within a range of those in serpentinites (Alt et al. 2012 EPSL). Olivine-hosted melt inclusions in arc basalts show a positive correlation between water contents and Fe3+/Fe2+ ratios (Kelley & Cottrell 2009 Science). The presence of sulfate ions in the Pinatubo aqueous fluid inclusions supports the correlation. Current estimate of S content in the aqueous fluids in forearc is much lower than that in melt inclusions in Mt. Shasta basalts (20-600mg S in 1g water; Le Voyer et al. 2010, J Petrol). This indicates that slab-derived fluids beneath sub-arc contain larger amount of S than in the Pinatubo fluid inclusions or that sulfur can be enriched from source mantle through its partial melting rather than addition by the slab-derived fluids.

Muriel Laubier
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Title: Redox sensors applied to olivine-hosted melt inclusions
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Abstract

The study of primitive olivine-hosted melt inclusions has allowed a better understanding of petrogenetic processes and mantle source regions. These unique samples may also provide a means to link the redox state in primary magmas to that in their mantle source. Arc magmas are more oxidized than mid-ocean ridge magmas [1], likely because the mantle source region of arc magmas has been modified by oxidized and fluids from the subducting slab. However, whether the variations in Fe3+/ΣFe of magmas from various environments arise owing to differences in mantle fO2 or to differentiation processes such as crystallization and degassing is still a matter of debate [2]. Alongside this scientific debate, Fe3+/ΣFe ratios in primitive melts also show discrepancies between values derived from different analytical methods (wet chemistry, XANES and Mössbauer spectroscopy) that clearly need to be resolved [3]. Here we combine different fO2 proxies in an attempt to carefully reconstruct mantle source fO2 from the compositions of highly primitive olivine-hosted melt inclusions from mid- ocean ridge, hot spot and arc settings. These fO2 proxies include Fe3+/ΣFe measurements and trace element proxies that rely on the experimental calibration of the partitioning behavior of multivalent cations such as V, Cu and S as a function of fO2 .

In particular we will compare fO2 values derived from the V oxybarometer [4] with direct measurements of the oxidation state of Fe. A careful assessment of the differentiation and melting processes and their effects on fO2 proxies will be carried out in order to reveal the link between redox state in melts and that of their mantle source. This work will provide an evaluation of the robustness of the various oxybarometers when applied to melt inclusions.

[1] Kelley & Cottrell (2009), Science 325, 605–607. [2] Gaillard et al. (2015), Chem. Geol. 418, 217-233. [3] Berry et al. (2018), EPSL 483, 114-123. [4] Mallmann & O'Neill (2013), J. Pet. 54, 933-949.

Allan Lerner
University of Oregon
Title: Sulfur degassing and magma oxidation state at Mount St. Helens (WA) and Augustine (AK) Volcanoes
Authors: A. Lerner, P. Wallace, C. Thornber, P. Kelly, M. Coombs, C. Mandeville

Abstract

Redox changes associated with magmatic sulfur (S) degassing can potentially change magma fO2, which in turn can affect phase stability, S solubility, and further degassing. We test whether S degassing and fO2 are linked in oxidized arc systems by undertaking a combined EPMA and µXANES study of Mount St. Helens and Augustine volcanoes.

We analyzed matrix glass and melt inclusions from the 1980 and 2004-2008 eruptions of Mount St. Helens and the 2006 eruption of Augustine. Sulfur in melt inclusions ranges from 40 – 340 ppm in Mount St. Helens samples and from 80 – 2600 ppm in Augustine samples, reflecting S degassing during stages of magma ascent and storage. At Mount St. Helens, µXANES melt inclusion measurements show a relatively narrow range of S speciation, and fO2 determinations largely overlap fO2 estimates from Fe-Ti oxides (ΔNNO 0 to +1). Augustine melt inclusions, in contrast, record a wider range of S concentrations and substantially more reduced melt fO2 (ΔNNO +0.2 to +1.2 via µXANES) than determined by Fe-Ti oxides (ΔNNO +1 to +2.5). Augustine melt inclusions generally become more oxidized with lower S contents, suggesting that S degassing may cause oxidation in this sulfur-rich system. Mount St. Helens is very S-poor overall and does not show such a relationship between S and fO2 changes.

In summary, we find that magmatic oxidation may be linked to S degassing, and that pre-eruptive fO2 conditions may be substantially different from fO2 recorded by Fe-Ti oxides.

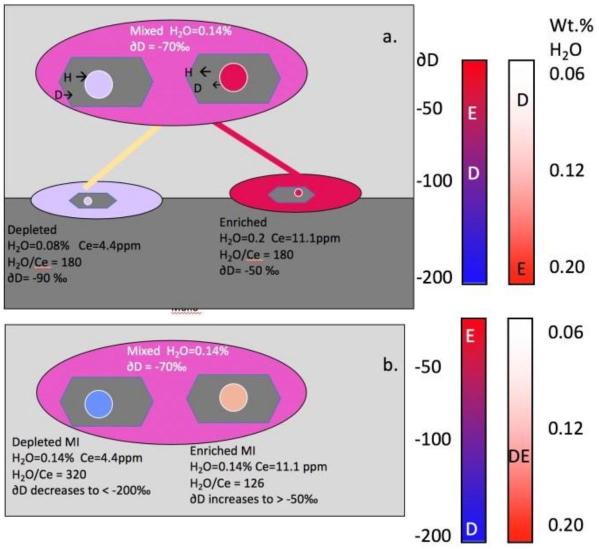
Peter Michael
University of Tulsa

Title: Low D/H in Baffin Island Melt Inclusions: Primordial Water or Diffusive Hydration?

Abstract

Fundamental questions remain concerning the timing, source, and delivery of water to the condensing Earth, and whether any part of the Earth retains primordial water. Discovery of low-Deuterium melt inclusions from Baffin Island lavas that were previously shown to have primordial noble gas signatures prompted Hallis et al. (2015) to conclude that there is primordial water in Earth, and that it was derived from the solar nebula by adsorption. But there is abundant experimental evidence for the mobility of hydrogen through olivine that shows how melt inclusions may be unreliable indicators of initial H2O contents and H-isotope ratios. The low H2O contents of the Baffin Island melt inclusions make them particularly susceptible to rehydration, which would produce inclusions with higher H2O and low D/H. I show several different physical mechanisms by which rehydration could occur. For example, mixing of diverse liquids just prior to eruption (Fig. 1a). In Fig 1 b., inclusions equilibrate with surrounding liquid, but D diffuses slower than H, leading to low-∂D, depleted inclusions (e.g., Hauri, 2002).

Hallis, L.J., et. al. (2015) Evidence for primordial water in Earth's deep mantle. Science 350, 795-797.
Hartley, M.E., et al. (2015) Diffusive over-hydration of olivine-hosted melt inclusions. Earth Planet. Sci. Lett. 425, 168-178
Hauri, E. (2002) SIMS analysis of volatiles in silicate glasses, 2: isotopes and abundances in Hawaii melt inclusions. Chem. Geol. 183,115



Brian Monteleone
Woods Hole Oceanographic Institution

Title: Using the Cameca IMS 1280 SIMS at WHOI to measure volatile concentrations and hydrogen isotopic compositions within melt inclusions and glasses of variable composition

Co-author: Glenn Gaetani, WHOI

Abstract

Secondary Ion Mass Spectrometry (SIMS) is a minimally destructive micro-analytical technique that is ideal for measuring volatile concentrations (CO2, H2O, F, S, Cl) and hydrogen isotopic compositions of

mineral hosted melt inclusions and volcanic glasses. Primary (133Cs+) beam focusing on the IMS 1280, when combined with secondary beam aperture application, allows for high quality analysis of most (e.g. bubble-, crack-, and mineral-inclusion free) melt inclusions as small as 10µm in shortest dimension. Typical precision on individual volatile concentration measurements is <3% for CO_2 (2RSD) and <2% (2RSD) for H_2O, F, S, and Cl. Bootstrap regression analysis on a calibration of multiple in-house basaltic glass standards yields typical accuracy of <5% 2 sigma for all volatiles. Recent developmental work has led to a substantial reduction in measured volatile backgrounds, with typical concentration measurements on volatile free materials (suprasil, synthetic forsterite) yielding <2µg/g CO_2, <4µg/g H_2O, and <.2µg/g for F, S, and Cl (at spot sizes > 30 µm). Further standard development will be geared toward matrix-matching common host minerals (e.g. olivine, pyroxene), thus enabling precise and accurate measurement of nominally anhydrous host minerals to allow for improved partition coefficient determination. Work on intermediate and felsic standards has shown a marked matrix effect on calibrations for CO_2 and H_2O with measured ratios of 12C/30Si decreasing with increasing SiO_2 wt% and 16O1H/30Si decreasing with increasing H_2O content in more silicic glasses. However, no such matrix effect exists for F, Cl, and S (Hauri et al, 2002). Hydrogen isotopes are measured on the IMS 1280 at high mass resolving power (MRP >8500), with the ratio of oxides (16O1D/16O1H) serving as a proxy for D/H. High MRP analysis of basalt and rhyolite standards at variable H_2O concentrations shows no discernable matrix effect with increasing SiO_2 or H_2O concentration.

Michelle Muth
University of Oregon

Title: The effect of slab-derived sulfur on the sulfur content, metal content, and oxidation state of primitive magmas in the Southern Cascades

Co-Authors: Paul J. Wallace, University of Oregon, Kristina J. Walowski, Middlebury College

Abstract

Arc magmas are oxidized relative to MORB, but the causes of this oxidized signature are uncertain. This study uses primitive olivine-hosted melt inclusions from the tephra of basaltic cinder cones in the Southern Cascades to investigate the role of slab-derived sulfur in the oxidation state, sulfur content, and chalcophile element behavior of primitive arc magmas. We integrate evidence for a hydrous slab component in Lassen primitive magmas from previous work [1] with evidence from major element, trace element, and chalcophile element concentrations in addition to fO_2 values from XANES analysis.

Sulfur concentrations in individual melt inclusions range from 883 to 2043 ppm. Cu, Zn, and Sn concentrations in melt inclusions range from 17 to 167 ppm, 65 to 124 ppm, and 0.5 to 1.5 ppm, respectively. Minimum fO_2 values inferred from S XANES range from QFM + 0.8 to QFM + 1.5. The fO_2 values for the different cinder cones correlate with S/Dy and Sr/Nd values and are consistent with the addition of oxidized, sulfur-carrying slab material to the Lassen sub-arc mantle. A subset of fO_2 melt inclusions contain small immiscible sulfide blebs. The sulfur contents of melt inclusions from these samples are close to sulfur concentrations predicted by sulfur solubility models [2,3], indicating the melts were near or at sulfide saturation during entrapment.
[1] Walowski et al. (2016) EPSL 446, 100-112. [2] Fortin et al. (2015) GCA 160, 100-116. [3] Jugo et al. (2010) GCA 74, 5926-5938.

Diego Fernando Narvaez Rivadeneira
Université Clermont Auvergne, IRD, Laboratoire Magmas et Volcans

Title: Evidence of different lithology sources and metasomatic agents under Ecuadorian volcanoes

Co-authors: Estelle F. Rose-Koga, Pablo Samaniego, Kenneth T. Koga

Abstract

We studied olivine-hosted melt inclusions from Sangay and Puñalica volcanoes, located in the southern termination of the Ecuadorian arc. The 30-150 µm melt inclusions were homogenized before we analyzed them under SEM, ICP-MS and SIM instruments for major, trace and volatiles composition, respectively. Two different lithologies (a peridotite and an amp-bearing clinopyroxenite) are needed to explain the major oxide variation of our melt inclusions. We also recognized two distinctive slab components that metazomatized the Ecuadorian sub-arc mantle. We propose that the different nature of the slab component is related to a distinctive thermal regime along the Benioff zone. We also state that Grijalva fracture zone, which enters in subduction in front of the Ecuadorian arc, is under Puñalica volcano allowing the increasing in volatile content (mainly F and Cl) in Puñalica melt inclusions.

Oded Navon
Institute of Earth Sciences, The Hebrew University of Jerusalem
Title: The analysis of high density fluid microinclusions in diamonds and garnet
Co-authors: Oded Elazar, Institute of Earth Sciences, The Hebrew University of Jerusalem
Ronit Kessel, Institute of Earth Sciences, The Hebrew University of Jerusalem

Abstract

The analysis of inclusions that are smaller than 1 µm is challenging, but when they are present in large numbers, a wealth of information may be collected on their composition. Microinclusions in diamonds are analyzed for their mineralogy and volatile content (TEM, FTIR and X-ray diffraction), major (EPMA) and trace elements (LA-ICP-MS) and isotopic composition. The transparent diamond matrix allows identification of water, carbonates, silicates and phosphates by IR spectroscopy. TEM finds these phases + halides as secondary multi-phase assemblages that formed during the cooling, at the surface, of a uniform high-density fluid (HDF) trapped by the diamonds during their growth in the mantle. The EPMA provides the bulk-composition of individual subsurface inclusions and reveals variation between four endmembers: a saline HDF, a high-Mg carbonatitic HDF and a continuous array between silicic and low-Mg carbonatitic HDF. LA-ICP-MS reveals two main trace-element patterns: "Planed" and "Ribbed" with negative anomalies in alkalis and the HFSE. Sr and Nd isotopes reveal derivation form the asthenosphere as well as old enriched lithosphere.

Recently we found silicic fluids in microinclusions in eclogitic garnets. The determination of their major elements is complicated because of the garnet matrix. We find that the trapped material is similar to the silicic to low-Mg carbonatite HDFs in diamonds, attesting to the involvement of HDFs in mantle metasomatism.

Roger Nielsen
Oregon State University
Title: The compositional consequences of natural and experimental diffusive re-equilibration on plagioclase hosted inclusions
Co-authors:Melissa Drignon - CEOAS, Oregon State University
Alisa Kotash -CEOAS, Oregon State University
Gokce Ustunisik -Geology and Geologic Engineering, South Dakota School of Mines
Frank Teply - CEOAS, Oregon State University
Robert Bodnar - Geosciences, Virginia Tech

Abstract

Interpretation of compositional information from melt inclusions requires that we understand the degree to which the melt inclusions represent the melt present at the time of entrapment. Our work focuses on plagioclase hosted melt inclusions from plagioclase ultraphyric basalts (PUB). This includes time series experiments on inclusion homogenization which document progressive partitioning of CO2 into the vapor bubble as a function of time and the diffusive exchange of both major elements and trace elements. Such changes can be attributed to the relaxation of the plagioclase structure during the heating of the crystal. Such relaxation is similar in type to that described by Schiavi et al (2016) for olivine - but take place on a much longer time scale (4 days vs 30 minutes).

Diffusive exchange manifests itself in both the experiments and in the naturally occurring megacrysts. In the experiments, profiles within the megacrysts leading up to the inclusions exhibit diffusion profiles for rapidly diffusing elements (e.g. Mg). Such profiles are present for 4 day run times but not for experimental run times of 30 minutes. In the megacrysts, some exhibit a relative narrow range of composition for rapidly diffusing elements (e.g. Sr) than for slow diffusing elements (e.g. Ti, Ce). However, local equilibrium appears to be maintained based on the fact that the ratio of trace elements between the MI and the host are similar to experimentally determined partition coefficients.

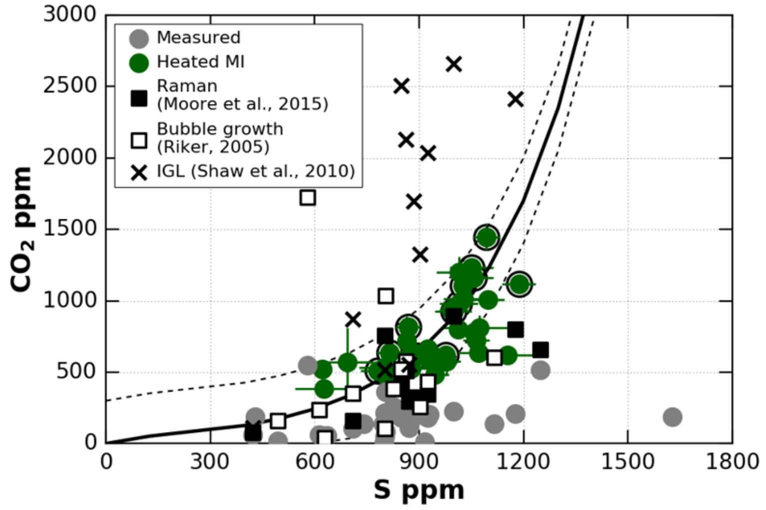
Daniel Rasmussen
Lamont Doherty Earth Observatory of Columbia University

Title: Reconstructing the CO2 contents of bubble-bearing, olivine-hosted melt inclusions

Authors: Daniel J. Rasmussen1, Terry A. Plank1, Leonid V. Danyushevsky2
1Lamont-Doherty Earth Observatory, Columbia University, New York, NY, USA
2Centre for Ore Deposit and Exploration Science (CODES), University of Tasmania, Hobart, Tasmania, Australia

Abstract

Melt inclusions provide a means to probe the depth and volatile content of magma. However, post-entrapment processes can lead to volatile exsolution (importantly CO2) into vapor bubbles inside inclusions. Methods to reconstruct entrapped CO2 contents yield inconsistent results. To reconcile the inconsistencies, we conducted homogenization experiments and bubble growth experiments. Homogenization experiments, in which inclusions were heated and vapor bubbles were resorbed, were conducted on inclusions from Seguam and Fuego volcanoes using a piston cylinder apparatus (~1150 °C, ~700 MPa, 2 hrs) with a KBr matrix and brucite as a water source. Most of the resultant inclusions are homogeneous. In each sample, CO2 and S contents are correlated, defining S-CO2 degassing paths. CO2 contents of unheated inclusions from the same samples were previously reconstructed using Raman addition (RA; Moore et al., 2015), and we have corrected CO2 with two computational approaches: the ideal gas law (IGL; Shaw et al., 2010) and a bubble growth model (BG; Riker, 2005). Relative to our empirical degassing paths, IGL results are offset to higher CO2 or lower S, while RA and BG results overlap but tend to be offset to lower CO2 or higher S. The discrepancies are attributed to CO2 because S contents of heated and unheated inclusions overlap. IGL may overestimate CO2 because CO2 diffusion cannot keep pace with bubble growth during rapid cooling upon eruption. Minute amounts of carbonate on the bubble interior may cause RA to underestimate CO2. BG discrepancies might relate to diffusive loss of H+ from unheated inclusions and uncertainties (e.g., temperature) involved with the calculation. Results will also be presented on Vernadsky heating stage experiments, conducted to observe bubble growth during cooling and diffusive loss of H+. Our ultimate goal is to use targeted homogenization and bubble growth experiments to create a more accurate calculation for restoring entrapped CO2 contents.



Federica Schiavi
Laboratoire Magmas et Volcans, Université Clermont-Auvergne, France
Title: The contribution of bubble-hosted mineral phases to the volatile content of melt inclusions estimated by 3D Raman imaging
Co-authors: Alejandra Gómez-Ulla - Univ. Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans, F-63000 Clermont-Ferrand, France; Dept. of Petrology and Geochemistry, Complutense Univ. of Madrid, 28040 Madrid, Spain; Swetha Venugopal - Univ. Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans, F-63000 Clermont-Ferrand, France; Simon Fraser Univ., 8888 University Drive, Burnaby, British Columbia; Manon Hardiagon - Univ. Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans, F-63000 Clermont-Ferrand, France; Nathalie Bolfan-Casanova - Univ. Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans, F-63000 Clermont-Ferrand, France; Didier Laporte - Univ. Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans, F-63000 Clermont-Ferrand, France

Abstract

Volatile abundances in magmas control the style, dynamics and intensity of volcanic eruptions. Reliable assessment of pre-eruptive conditions and degassing budget depends on correct estimation of the original volatile contents of magmas. Phenocryst-hosted melt inclusions (MI) record the volatile contents of the magma at the time of MI entrapment. During magma ascent and eruption, bubbles often form inside MI due to pressure drop and cooling. Recent studies have shown that up to 40-90% of the CO2 initially contained in MI is sequestered inside bubbles [1]. In addition to a fluid phase, bubbles often contain solid phases crystallized on the bubble wall. Raman spectroscopy measurements indicate that the volume of these solid phases (mainly carbonates and sulphates) relative to the fluid phase may be important. We present a method to identify the different phases filling inclusion-hosted bubbles and to quantify the volume of the solid phases using 3D Raman imaging. The method is applied to the study of olivine-hosted MI of basanitic and basaltic compositions erupted from different volcanoes. The accuracy and the limits of the method are examined by performing 3D Raman imaging of bubbles in silicate glasses synthesized in the laboratory. The contribution of bubble-filling mineral phases to the MI volatile content is quantified and discussed.

[1] Wallace et al. (2015) Am Mineral 100, 787-794.

Kei Shimizu
Department of Terrestrial Magnetism, Carnegie Institution for Science
Title: The role of melt-rock interaction on the CO2/Ba ratio of depleted MORBs
Co-authors: Alberto E. Saal, Erik H. Hauri, Michael R. Perfit, Roger Hékinian

Abstract

Carbon content of the depleted upper mantle has been estimated using CO2/Ba in depleted mid-ocean ridge basalt (D-MORB) melt inclusions and glasses that are undersaturated in CO2. One of the potential issues with this approach is the effect of melt-plagioclase chemical interaction on the CO2/Ba ratios in D-MORBs. Assimilation of plagioclase-bearing rocks into MORB has been shown to affect their Ba (and Sr and Eu) concentrations, implying that such a process may also affect their CO2/Ba ratio. In this study, we report on the compositions of olivine-hosted melt inclusions and glasses from the Siqueiros and Garrett transform faults. The melt inclusions are CO2 undersaturated D-MORBs with highly depleted incompatible trace element compositions. Subsets of melt inclusions from both transform faults show signatures of assimilation of plagioclase such as significant increases in Al2O3 and decreases in FeO with decreasing MgO, positive Sr anomalies, and low Nb/Ba. CO2/Ba ratios significant ranges of 113±48 and 86±40 for the Garrett and Siqueiros melt inclusions respectively. We model assimilation fractional crystallization of plagioclase into the D-MORBs. These models reproduce the range in CO2/Ba ratio and trends between CO2/Ba, Nb/Ba, and Nd/Sr as well as between Al2O3, FeO, and MgO observed in the melt inclusions. Hence, chemical interaction with plagioclase may affect the CO2/Ba ratio in D-MORBs, and care should be taken to evaluate this effect using Nd/Sr and Nb/Ba ratios.

Kenji Shimizu
Kochi, JAMSTEC

Title: Comprehensive volatile analyses of ~30 µm melt inclusion using SIMS

Co-authors: Takayuki Ushikubo (Kochi, JAMSTEC), Tomokazu Murai (Tokyo Inst. Tech.), Fumihiro Matsu'ura (Tokyo Inst. Tech.), and Yuichiro Ueno (Tokyo Inst. Tech.)

Abstract

We developed in-situ analyses of volatile contents, hydrogen and sulfur isotopes of basaltic glass using IMS-1280HR at Kochi Institute, JAMSTEC. Series of standards were prepared including synthetic and natural basaltic glasses to cover the broad ranges of volatile contents in basaltic glasses reported to date. H2O and CO2 concentrations of the standard glasses were determined by FTIR, and concentrations of F, Cl, and S were determined by ion chromatography following pyrohydrolysis (Shimizu et al., 2017, Geochem. J. 51, 299-313). Hydrogen and sulfur isotope ratios were determined by TCEA/IRMS and IRMS, respectively at Tokyo Institute of Technology.

For the in-situ analysis of volatile contents and sulfur isotope, defocused Cs beam (~0.5nA) of ~10µm was used, but for hydrogen isotope, we used larger defocused beam (~5nA, ~15µm). Secondary ions of volatile elements were detected by an axial EM using a magnetic peak switching method to determine volatile contents. For analyses of D/H (34S/32S) ratios, 16OH (32S) and 16OD (34S) were measured in multi-detection mode with a Faraday cup and an axial EM, respectively. Each measurement time is ~6 minutes. Precision for D/H and 34S/32S ratios are ±5‰(2sd) (H2O>1wt%) and ± 0.6 ‰ (S>1000ppm), respectively. Our developed analyses of rapid, accurate, and high spatial resolution can determine multi-elements and isotopes of volatiles in a single small melt inclusion (Figure 1).

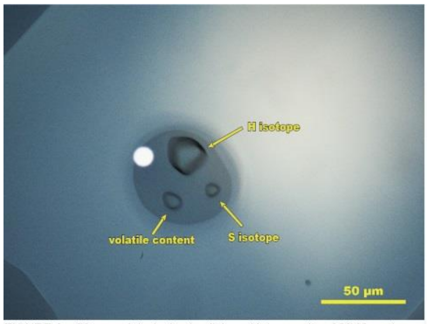


FIGURE 1: ~50µm melt inclusion in olivine with beam pits of SIMS analyses of volatile (H_2O, CO_2, S, F, Cl) concentrations and H and S isotopic ratios.

Jonathan Tucker
Carnegie Institution for Science

Title: A high carbon content of the Hawaiian mantle from olivine-hosted melt inclusions

Co-authors: Erik H. Hauri, Carnegie Institution for Science; Jared P. Marske, California Institute of Technology; Michael O. Garcia, University of Hawaii; Aaron J. Pietruszka, USGS; Frank A. Trusdell, USGS

Abstract

Quantification of CO2 in melt inclusions is complicated by the ubiquitous presence of vapor or “shrinkage” bubbles. We measured exsolved vapor bubble CO2 by a volumetric method, and dissolved CO2 by SIMS, in order to reconstruct total melt inclusion CO2 concentrations in >400 Hawaiian melt inclusions. Unlike a similar method by Raman spectroscopy, our method accounts for the presence of cryptic carbonates, which may sequester much of the vapor bubble CO2.

We find that vapor bubbles often contain ~90% of the inclusion's CO2. Importantly, we demonstrate that addition of vapor bubble CO2 to dissolved CO2 results in ~50% uncertainty in total melt inclusion CO2, primarily due to melt inclusion geometry. This same uncertainty is also applicable to Raman studies. Therefore, due to this uncertainty, large numbers of samples must be measured in order to accurately capture population statistics.

Based on our data set, we estimate that parental melts from five Hawaiian volcanoes have between 0.24 and 1.1% CO2, with mantle sources between 130 and 490 ppm CO2. The average mantle source of the five volcanoes has 315 ppm CO2, suggesting that the Hawaiian plume is significantly more C-rich than the MORB mantle. The high CO2 concentration of the Hawaiian plume could either be due to deeply subducted surficial C, retention of juvenile C, or both.

Gokce Ustunisik
South Dakota School of Mines & Technology

Title: Diffusive Re-Equilibriation of Plagioclase-Hosted MIs and their Host: Insights from Analytical Data, Modeling, and Experiments

Co-authors: Roger L. Nielsen, Oregon State University; Frank Tepley, Oregon State University; Melissa Drignon, Oregon State University; Alisa Kotash, Oregon State University

Abstract

Interpretation of compositional information from melt inclusions requires that we understand the degree to which the melt inclusions represent the melt present at the time of entrapment. Our work focuses on plagioclase hosted melt inclusions from plagioclase ultraphyric basalts (PUB). This includes time series experiments on inclusion homogenization which document progressive partitioning of CO2 into the vapor bubble as a function of time and the diffusive exchange of both major elements and trace elements. Such changes can be attributed to the relaxation of the plagioclase structure during the heating of the crystal. Such relaxation is similar in type to that described by Schiavi et al (2016) for olivine - but take place on a much longer time scale (4 days vs 30 minutes).

Diffusive exchange manifests itself in both the experiments and in the naturally occurring megacrysts. In the experiments, profiles within the megacrysts leading up to the inclusions exhibit diffusion profiles for rapidly diffusing elements (e.g. Mg). Such profiles are present for 4 day run times but not for experimental run times of 30 minutes. In the megacrysts, some exhibit a relative narrow range of composition for rapidly diffusing elements (e.g. Sr) than for slow diffusing elements (e.g. Ti, Ce). However, local equilibrium appears to be maintained based on the fact that the ratio of trace elements between the MI and the host are similar to experimentally determined partition coefficients.

Yuxiang Zhang
Woods Hole Oceanographic Institution

Title: Hydration induced hydrogen isotope fractionation in olivine-hosted melt inclusions: an experimental study

Co-authors: Glenn Gaetani, Ayla Pamukcu, Brian Monteleone, WHOI

Abstract

Olivine-hosted melt inclusions from mantle-derived lavas have been used to investigate the hydrogen isotopic composition (D/H) of the Earth's deep reservoirs, which are key to understanding the origin of water on Earth (Hallis et al., 2015). However, experimental studies have demonstrated that olivine-hosted melt inclusions show open system behavior for water (Gaetani et al., 2012). Significant hydrogen isotope fractionation can occur in melt inclusions during diffusive dehydration or hydration of the host olivine. As H2O in the melt inclusion re-equilibrates with the external magma, deuterons diffuse through host olivine slower than protons. In such cases, a negative correlation develops between water contents and D/H ratios in some olivine-hosted melt inclusions. To quantify this process during olivine hydration, which could occur when the carrier melt is mixed with a more hydrous melt just prior to eruption, hydration experiments were performed on olivines from Puu Mahana, Hawaii. The melt inclusions in these olivines have initially low water contents (0.27 to 0.39 wt.%) and relatively large variation of δDVSMOW values (-65 to -104‰). Olivines were held at 300 MPa and 1200°C in pure distilled water (δDVSMOW=0) for 30 min, 60 min, and 90 min. All run products were analyzed for H2O concentrations and D/H ratios by SIMS on the Cameca 1280 ion microprobe at WHOI. The hydrated melt inclusions have increased water contents (0.39 to 1.47 wt.%) and decreased δD values (-100.3 to -178.6‰) as hydration progresses, and a negative H2O-δD correlation was produced. Additionally, in each run, negative correlations have been found between water contents and MI sizes and between δD values and olivine sizes. Our hydration experiments well reproduced the hydrogen isotope fractionation trend produced by a numerical olivine hydration model (Qin et al., 1992) based on the same olivine geometry and a hydrogen diffusivity of 6.16×10-12 m2/s at 1200 °C (parallel to [001]).