

the ASCT have significantly higher values suggesting ages > 100 years, and several samples from the margins of the ASCT have values implying they are at least several hundred years old. These old ages are difficult to reconcile with eruptive frequencies of < 10 years that have been suggested for fast spreading ridges, unless eruptive volumes are small. Off-axis paleointensities generally follow a pattern with distance from the axis consistent with independent records of changes in intensity with time. For example, high values are common up to 2 km from the axis, with decreasing values farther away from the axis. This agrees well with other observations of young flows up to 2 km from the axis. Low paleointensities, presumably reflecting the dipole intensity minimum near 40 ka, are typically found 3-4 km from the axis but also occur as close as 2 km off axis (the nominal distance for 40 ka crust). If the latter samples also represent the same intensity low near 40 ka, this would suggest minimal off axis volcanism at this locality. The paleointensity data also provide a powerful age discriminant when used in conjunction with geochemical data. For example, we distinguish adjacent samples with identical chemistry but with distinct paleointensities that imply a time separation of hundreds or thousands of years. We also identify samples with substantially different geochemistry but with indistinguishable paleointensities, suggesting that they may have been erupted very close together in time.

V52A-1283 1330h POSTER

Possible Recent Volcanic Activity on the East Pacific Rise at 9° 32'N

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In 2001, the DSL-120A near-bottom mapping system was used to survey a 31.4 km by 6.8 km corridor of the East Pacific Rise crest between 9° 25'N and 9° 57'N. The mapping system included a 120 kHz sidescan and interferometric bathymetry sonar that was used to produce 2 meter-resolution sidescan images of the corridor. The sidescan data depict three scarps located approximately 3 km west of the ridge axis that are interpreted to have been volcanically overprinted between 9° 31'N and 9° 32'N on the basis of sharply lineated features that are interrupted along-strike. In transcripts, video, and 35 mm film footage of the same region collected during Alvin Dive 2490 in 1992, these same scarps are documented as two inward-facing and one outward-facing vertical walls that are 17-18 m high. Co-registration of the DSL-120A and Alvin 2490 datasets shows a strong correlation between other features that are depicted in both the acoustic and photographic data, but the appearance of the scarps changes markedly between 1992 and 2001.

In the DSL-120A sidescan data, amorphous-shaped regions of relatively high backscatter characterize the area where the scarps are thought to be volcanically overprinted. In some cases, these reflective patches appear to pond at the base of faults or to spill over the faults. To verify whether the morphology changes between 1992 and 2001 reflect recent volcanic activity on the flank of the ridge axis, we have located SeaMARC-II data for the same region collected in 1987. A cursory examination of the much lower-resolution SeaMARC-II sidescan images vaguely shows the presence of similarly-shaped reflective scarps in the approximate location of the new flow. We are presently reprocessing the SeaMARC-II data to improve the data resolution, making a map from the DSL-120A bathymetry data, and searching for additional datasets that may confirm the existence of a new off-axis flow. The results of our efforts will be reported in December.

V52A-1284 1330h POSTER

Depleted Peridotites of Macquarie Island, an Uplifted Section of In-situ Oceanic Crust

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Macquarie Island, located 1500 km southeast of southernmost Australia, is thought to be the sole complete section of ocean crust uplifted in the ocean basin in which it formed. It is an exposure of the Macquarie Ridge complex, which marks the modern Australian-Pacific plate boundary. The oceanic crust of the island formed in the final stages of spreading, ~6 mya, as indicated by Ar-Ar plateau ages of basaltic glass. Geometries of marine faults on the island suggest that it formed near the intersection of a ridge and a transform. At this latitude, the plate boundary evolved from a spreading ridge to a transpressional boundary between ~33 and ~6 mya, thus the rocks of the island record an interesting tectonic history and may provide clues to the mantle process during a major plate motion re-organization. Residual, plagioclase-free mantle peridotite samples were collected along transects through all of the mantle sections on the island, with an average of 100 meter spacing between samples.

Orthopyroxenes, clinopyroxenes and chrome spinels were analysed by electron microprobe. Spinel chrome numbers (Cr-nr) ranged from 0.39 to 0.46 (n=23), which corresponds to 15-16% fractional melting applying the empirical melting equation of Hellebrand et al (2001). Their low Ti contents (0.02-0.07) attest to the residual nature of the Macquarie Island peridotites. Cpx is preserved in only 7 samples (alteration, depletion), and occurs mainly as small interstitial grains or as exsolved blebs in opx porphyroclasts. Cpx titanium (0.00 0.04 wt% TiO2) and sodium (0.00 0.05 wt% Na2O) contents are extremely low, confirming the high depletion and supporting highly efficient melt extraction. Opx porphyroclast cores have very high Mg-nr (0.92 on average).

Spreading rates at the time of formation of the Macquarie Island crust have been calculated to be 30mm/yr (full) which is considered slow. However, the levels of depletion indicated by the spinel Cr-nr and Ti and Na contents of cpx of the Macquarie Island peridotites are more similar to those seen at fast spreading centers or ophiolites. This depletion could be caused by the progressively changing spreading direction disrupts mixing in the mantle, causing repeated melting of the same mantle source or biased sampling in the existing abyssal peridotite database. Further analyses of peridotites and associated basalts will test which model is most likely.

Hellebrand et al., (2001) Nature 410, 677-681.

V52A-1285 1330h POSTER

Normal and Abnormal Major Element Variations in Lavas from Intermediate Spreading Centers: SEIR and Galapagos

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The Galapagos Spreading Center (GSC) and the Southeast Indian Ridge are major intermediate spreading centers that encompass significant gradients in depth and mantle temperature. Major elements contents of lavas sampled along these ridges, across the depth gradients vary in significantly different ways. With the exception of the hotspot-influenced Amsterdam-St Paul platform, the shallowest point (~2500 meters) on the SEIR is near 90°W while the deepest (>4500 m) region is between 115°W and 127°W, within The Australian Antarctic Discordance (AAD). Between these regions, a steady eastward depth increase in axial depth is accompanied by increasing Na8 and decreasing Fe8, consistent with the well-known global correlations of these parameters with axial depth. Along the Galapagos Spreading Center, the thermal influence of the nearby Galapagos hotspot causes axial depths to shoal by more than 1000 meters as the locus of maximum hotspot influence near 91°W is approached from both east and west. This effect is mirrored by regional increases in Sr and Nd isotopic ratios (Schilling et al., 1982; Verma et al., 1983). New analyses of basalt glasses collected from the GSC east of the hotspot during the MEGAPRINT expedition of R/V Sonne confirm the observation of Klein and Langmuir (1987) that values for GSC lavas do not conform to the global trend, as do recently published data from the G-Prime expedition to the western GSC (Detrick

et al., 2002). Along-axis Na8 and Fe8 profiles east and west of 91°W are not, however, mirror images. For the eastern GSC, Na8 and Fe8 are positively correlated and cut at a high angle across the global trend. We can use this cross cutting trend, in combination with other geochemical and geophysical data to assess the combined effects of gradients in source composition, mantle temperature and magma system geometry on the compositions of erupted lavas. In recent years, a number of studies of mid-ocean basalts have used Na8, Fe8 and other major element parameters to calculate pressures, temperatures and extents of melting. If we apply such calculations to eastern GSC lavas, the results are clearly in error because of the extreme effects of the along-axis gradients. In this poster, we use the magnitude of such errors to explore the variability of mantle source composition, properties and processes.

V52B MCC: Hall C Friday 1330h

Geochronology and Related Topics Posters

Presiding: T Torgersen, University of Connecticut

V52B-1286 1330h POSTER

⁴⁰Ar/³⁹Ar dating of the UG-2 Vein of the Bushveld Complex (South Africa): The diversity of spectra.

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The UG-2 vein (upper critical zone) is one of the prominent Pt-group enrichment zones in the Bushveld Complex (South Africa). Eleven individual phlogopite crystals were degassed incrementally with a CO2 laser in 30 to 40 steps each. The apparent age spectra display widely varying characteristics, ranging from essentially 100% concordant to strongly discordant (in some cases unidulatory). All discordant spectra display common features; 1) apparent low age in the first 10 to 20% of the spectrum; 2) higher ³⁷Ar_{Ca}/³⁹Ar_K ratio (0.4 to 0.2). These spectra are good examples of the variable effects of ³⁹Ar recoil during irradiation in interlayer chlorite as observed in other studies of Fe-Mg micas (Lo and Onstott, 1989). In such spectra, plateau-like segments (more than 50% of the ³⁹Ar released) can be found even in highly discordant spectra and the more discordant spectra coincide with the oldest plateau "ages" (2106 +/- 12 Ma; analytical errors only). In such cases the integrated ages are better clustered than plateau ages. The least discordant spectra (90 to 100% of the ³⁹Ar released) yield integrated and plateau ages ranging between 2034 and 2047 Ma (based on Steiger and Jäger (1977) decay constants and 28.02 Ma for the FCs standard; Renne et al., 1998), slightly younger than existing constraints from U/Pb dating (Ca: 2059 Ma, Buick et al., 2001). If the recently inferred ca. 1% bias between currently used calibrations of the ⁴⁰Ar/³⁹Ar and U/Pb systems in valid, this implies a very rapid cooling rate for this part of the Bushveld Complex as proposed by Cawthorn and Walraven (1998). Nevertheless the possibility of subtle bias due to excess ⁴⁰Ar and unobviated recoil artifacts must be considered. In all cases, the heterogeneous age spectra reveal the likelihood for erroneous conclusions to be drawn from less complete data sets. The observed complexities also underscore the stringent requirements for data which can be used objectively to constrain the inter-system bias between U/Pb and ⁴⁰Ar/³⁹Ar.

V52B-1287 1330h POSTER

Reconciling in situ Cosmogenic ³⁶Cl Production Rate Estimates

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The suitability of using cosmogenic nuclides for determining surface-exposure ages and rates of geomorphic processes depends upon the accuracy with which

nuclide-specific production rates are known. Existing production rate estimates are based on calibration studies that use geological samples with independently constrained exposure ages. Published production rate estimates for cosmogenic ^{36}Cl are highly variable, and differ by up to 20% and 65% for spallation of ^{40}Ca and ^{39}K , and 10% for thermal neutron capture by ^{35}Cl . These discrepancies can be attributed to several factors. Parameterizations of thermal and epithermal neutron fluxes, muogenic production rates, and methods of scaling for geomagnetic and atmospheric shielding have changed significantly in recent years, and are incorporated differently in each study. Each study also uses a completely different calibration dataset, and most concentrate on only one or two sample sites and geological landforms. Limiting the dataset to only a few sample locations may bias production rate estimates if the site has unsuspected complications in its exposure history or independent age estimate, or if scaling parameterizations are inaccurate. Furthermore, limiting the number and distribution of sites used in production rate parameter estimation reduces the scope of inference and applicability of production rate estimates and may produce biased ages if used for prediction at other locations.

Here, I examine the influence of these biases on production rate estimates and attempt to reconcile the data from existing production rate studies. A regression on the full set of calibration data produces an equation with a strong degree of predictability ($R^2 > 0.97$). New production rate estimates for ^{36}Cl , using the full calibration dataset from previous studies and accounting for these sources of bias, will be presented.

V52B-1288 1330h POSTER

Chlorine-36 Exposure Dating of Recent Explosive Events on Mauna Loa, Hawaii

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We have dated lavas and explosive debris from around the summit caldera of Mauna Loa using in-situ produced cosmogenic Cl-36. Explosive deposits occur as three debris aprons of blocks up to 2 meters. Within the ejecta debris are intrusive rocks (gabbros, pyroxenites), and vesicular and dense basalts. The pahoehoe substrate of the northwest fan has an apparent exposure age of 970 +/- 120 years, in good agreement with radiocarbon ages that range in age from 1090 1200 yr B.P. Three clasts from the NW fan have exposure ages ranging from 930 +/- 120 to 1140 +/- 120 years, indicating an explosive eruption occurred very shortly after emplacement of the underlying flow. These ages should be regarded as upper limits until we have confirmed that Cl-36/Cl ratios are low in freshly erupted Mauna Loa basalt. Low initial ratios (<1e-15) are anticipated based on magmatic U, Th and Cl concentrations and likely magma chamber residence times. Low ratios would also result from assimilation of marine chloride with Cl-36/Cl <1e-15. However, assimilation of surficial material, or magmatic interaction with Cl-36 bearing groundwater might result in higher initial values. We are measuring samples from the 1975 and 1984 eruptions to investigate these possibilities.

V52B-1289 1330h POSTER

Testing cosmogenic nuclide production rate scaling models using in situ cosmogenic ^{14}C from surfaces at secular equilibrium: Preliminary results

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A cornerstone of applications utilizing in situ cosmogenic nuclides is the ability to scale production rates from the few sites where they are well established to sites under study. Theoretical scaling models currently used for this purpose (e.g., Lal, 1991, EPSL 104, p. 424; Dunai, 2001, EPFL 193, p. 197) are based on modern measurements of cosmic ray variation with latitude and altitude. However, these models have never been thoroughly tested empirically using significant numbers of geologic samples.

The main problem in addressing this issue is the scarcity of samples of well-established age. However, the recent development of a reliable extraction method for in situ cosmogenic ^{14}C (in situ ^{14}C) from quartz (Lifton et al., 2001, GCA 65, p. 1953) provides a unique opportunity to test these theoretical models empirically. Unlike other commonly used in situ cosmogenic nuclides, ^{14}C has a short half-life that allows attainment of secular equilibrium, or saturation, in approximately 20 ky. Also, ^{14}C loss from decay far outstrips loss from erosion in many geomorphic settings. Under such conditions, the measured concentration of in situ ^{14}C is only a function of its integrated average production rate. These aspects of the in situ ^{14}C system make a wide range of landscape features suitable for production rate determinations.

We have sampled a mid-latitude altitude transect to assess the altitudinal dependence of integrated late Quaternary in situ ^{14}C production rates. Sampling site altitudes range from near sea level in Death Valley, CA, to nearly 3.9 km in the Inyo-White Mountains, CA. Low-altitude samples were collected from sites on stable alluvial fan surfaces exhibiting well-developed desert pavements, while high-altitude samples were collected from stable bedrock sites with low local relief. Preliminary results are consistent with both the Lal (1991) and Dunai (2001) scaling models, which do not differ significantly along the transect. A significant muogenic ^{14}C component (Heisinger et al., 2002, EPSL 200, p. 357) is not resolvable within the uncertainties of these data. We also plan to present data from saturated surfaces at other latitudes and altitudes to assess further the applicability of published scaling models over the late Quaternary.

V52B-1290 1330h POSTER

U-Th-He age determinations on volcanic rocks: A new tool for Quaternary geochronology.

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The U-Th/He system, which has been used successfully for thermochronology, also has potential for dating young volcanic rocks. To test this possibility the age of garnet phenocrysts from the 79 AD eruption of Mt. Vesuvius was measured. The samples consisted of 600-1000 μm diameter andradite-grossular garnet crystals separated from a volcanic tuff previously dated by Ar-Ar (Renne et al., 1997). Our age calculation accounts for diffusive loss of radiogenic He since eruption, loss of He by alpha ejection from the garnet grains, U series disequilibrium, and non-uniform U-Th distribution within the mineral grains. The effect of diffusion was investigated using existing diffusivity and activation energy data for almandine rich garnet (Dunai and Roselieb, 1996), and by step-wise degassing of the Vesuvius garnets. Diffusivity was measured over 7 temperature steps ranging from 800°C to 1300°C with one additional 1500°C step for complete extraction. Even up to the 1300°C step the diffusivity remains linear, indicating an Arrhenius relationship with an activation energy of approximately 427 kJ/mol and a frequency factor, $D_0/a^2 = 0.578 \text{ s}^{-1}$. Alpha emission is accounted for by modeling the garnet grains as spheres with the injection and ejection of alphas from the sphere depending on the concentration and distribution of the U and Th inside and outside of the mineral grain. Distribution of U, Th was determined by ion-probe analysis across garnet grains in thin section. While the overall concentration of U and Th within the garnets is quite high (approximately 16-19ppm and 23-27ppm, respectively), there is a deficiency in ^{230}Th and ^{226}Ra . The $^{234}\text{U}/^{238}\text{U}$ and $^{230}\text{Th}/^{238}\text{U}$ activity we measure directly, while the $^{226}\text{Ra}/^{238}\text{U}$ activity ratio was esti-

mated by assuming Ra follows barium. Due to machine limitations, U, Th concentrations and He concentrations were determined on different aliquots. The measured concentration of ^4He in the garnet grains varies from 3.72×10^{-9} to 4.16×10^{-9} cc STP/g, giving us a range in the calculated age of approximately 1820 ± 140 yr. These results suggest that with the proper analysis and corrections, we can apply the U-Th/He method to dating young volcanic minerals. The potential value of the method is that it can provide ages for rocks as young as a few thousand years and as old as several million years, supplementing the radiocarbon and K-Ar approaches in this critical age range.

Renne, P.R., W.D. Sharp, A.L. Deino, G. Orsi, L. Civetta, *Science* 277 (5330), 1279-1280, 1997

Dunai, T.J., K. Roselieb, *Earth and Planetary Science Letters* 139 (3-4), 411-451, 1996

V52B-1291 1330h POSTER

Diffusive Separation of Noble Gases by adsorption and throat constrictions: Explaining Noble Gas patterns in Sedimentary Rocks

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Literature reports of noble gas patterns in sedimentary rocks indicate a commonplace occurrence of both Xe- and Ne-enriched endmembers, which occur either separately or together. Laboratory experiments have shown that noble gases appear to rapidly and weakly physio-adsorb on natural rock material. However, the weak physio-adsorption bond quickly changes to a strong chemi-sorption mode, such that adsorption at low temperature requires a higher temperature to extract the adsorbed component. This suggests that mechanisms are operational in sedimentary rocks that appear to first adsorb and then trap noble gases. More recently, based on measurements of both Xe- and Ne-enrichment in fluids from hydrocarbon systems, it has been suggested that the light and heavy noble gas enrichments occur in the fluid due to direct transfer of noble gas enrichments from the reservoir and/or source rock to the fluid with a subsequent evolution of the fluid. We present a simple model, based on labyrinth-with-constrictions (e.g. Wacker et al., 1986), to explain noble gas enrichment patterns in sedimentary rock that does not require any special process and/or unusual conditions yet provides zeroth order explanations for noble enrichments, trapping and geologic release from/to terrestrial rocks.

Using estimates of the relative (1) diffusion coefficients, (2) adsorption coefficients and (3) probabilities for noble gas passage through a constricted throat (all functions of atomic mass), we find the above three properties of noble gases combine to allow a diffusive separation of Ne, Ar, Kr and Xe with a change in boundary condition. This simple theory is consistent with literature reported noble gas enrichment and concentrations in sedimentary rocks. Xe enrichments can be produced as a residual in rock following a decrease in exterior noble gas concentration; Ne enrichments can be produced by an increase in exterior noble gas concentration. The time scale for separation is governed by the above three parameters as well as the characteristic grain size around which the boundary conditions change. Thus noble gas enrichment patterns may be interpretable as metamorphic-like process-driven signals reflecting e.g. geothermal heating, diagenesis, metamorphism, methanogenesis, and oil maturation.

V52B-1292 1330h POSTER

Who Needs Uranium? Pb-Pb Dating of (and Temporal Resolution in) Zircon

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A method akin to *Differential Isotope Correlation* (Tera, 2000 & 2002) is applied to 204Pb-depleted systems (e.g., zircons), where 206Pb/208Pb and 207Pb/208Pb are plotted separately versus the same X-axis of 207Pb/206Pb or (206Pb/208Pb)-(207Pb/208Pb). Because of the general transparency of isotopic ratios to recent U-Pb mobility, these correlations usually project less obscured patterns, which are reiterated in the two diagrams. The redundancy allows correlated filtration of aberrant data, thus resulting in sharper lineation. The justification of *filtration through redundancy (FTR)* is in the concurrent emergence of synchronism (that is, co-incidence of reason) from the two diagrams. Each

judiciously filtered line is the result of mixing of two end-members: (1) initial Pb and (2) in-situ produced Pb (through U & Th decay). A system of a single age can have multiple lines, each corresponding to a specific $K = Th / U$ for the in-situ component. If such a system is not complicated beyond recent mobilities, the lines would converge to intersect at a point corresponding to initial Pb (see Fig. 3, Tera, 1983). The 206, 207, 208Pb plots mentioned are referred to here as *Quasi Differential Diagrams*.

When the data of the filtered lines, obtained as described above, are plotted on an age-producing diagram of 206Pb/208Pb Vs 207Pb/208Pb they would produce a single line, the slope of which yields the age as is conventionally calculated. Thus without measuring the often hopelessly non-correlated U (mostly because of prevalent recent U-Pb mobility), a uranium-enriched mineral (e. g., zircon), may be accurately dated. Furthermore, two other aspects of evolution-history may be revealed: (1) In a case where determination of initial Pb on a Quasi Differential Diagram was possible, the age of the source is calculable in a straightforward fashion from the radiogenic ratio of 207Pb/206Pb; (2) Events resulting in coexisting re-equilibrated domains may be resolvable into discrete dates.

The filtered Pb-Pb results of a given geologic system can be contrasted with the U-Pb data plotted (on a concordia diagram) as a superposition of a deformation on a pre-existing frame (inferred from the Pb-Pb data). Illumination of processes and mechanisms may follow. Applications demonstrating the practicality of the method (termed *Lead-Uranium Consecutive Isotope Depiction* or *LUCID*) exist and will be presented. Collectively, they expose all the above mentioned features.

A note of caution: as it stands *FTR* is mediated through pattern-recognition by a human, thus it may carry within a potential component of bias. Bias may be eliminated or minimized through the adoption of a statistical approach, which has yet to be developed. References: Tera, F. (2000a) Lunar Planet. Sci. conf., (2000b) AGU Spring Meeting V22B, (2002) *Geochim. Cosmochim. Acta*, in press; Tera F. (1983) *Earth Planet. Sci. Lett.* 63, 147-165.

V52B-1293 1330h POSTER

The ^{176}Lu Decay Constant Controversy

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The Lu-Hf systematics of Earth's earliest zircons and rocks provide clues about the differentiation of the mantle into depleted and enriched reservoirs. However, initial ϵHf values and the interpretations derived from them hinge on the accuracy and precision of the ^{176}Lu decay constant. At present, there is still a serious discrepancy between 1) ^{176}Lu decay constants determined by physical counting methods and age comparisons of terrestrial samples, and 2) those determined by age comparisons of meteorite suites. The mean Lu decay constant determined by the two most recent physical decay counting experiments [1, 2] together with 4 independent geological age comparisons [3] is $1.87 \times 10^{-11} \text{yr}^{-1}$. In contrast, decay constants determined by age comparisons in meteorites are systematically higher, with a mean value of $1.95 \times 10^{-11} \text{yr}^{-1}$ (including eucrite data from [4, 5, 7, and this abstract] and chondrite data from [6]). The slope of a Lu-Hf isochron for four eucrites (Juvinas, Millbillillie, Pasamonte, and Moama) analyzed at Mnster by MC-ICPMS would suggest a decay constant of $1.97 \times 10^{-11} \text{yr}^{-1}$. Since the terrestrial age comparisons in [3] were made using the same methods and spike calibrations as for the Muenster eucrite isochron, the disagreement between the two sets of decay constants is apparently not an inter-laboratory artifact. Rather, a possible explanation for the disagreement may be that the meteorites do not conform to all of the assumptions required for an isochron (e.g., that all samples have the same age, all have the same initial Hf isotope composition).

The Lu decay constant discrepancy must be resolved before any robust interpretations can be drawn from the initial ϵHf of Archean or Hadean samples with Lu/Hf ratios that differ significantly from the chondritic value (e.g., zircons). The existing Hf data viewed in light of a high decay constant would suggest substantial mantle depletion in the early Archean without much evidence for a complementary enriched reservoir. On the other hand, the low decay constant would provide evidence for small volumes of enriched reservoirs, but no large-scale mantle depletion.

[1] Dalmaso et al. 1992. *Appl. Radiat. Isot.* 43: 69-76. [2] Nir-El and Lavi 1998. *Appl. Radiat. Isot.* 49: 1653-1655. [3] E.E. Scherer et al. 2002. *Science* 293: 683-687. [4] Patchett and Tatsumoto 1980. *Nature* 288: 571-574. [5] Tatsumoto et al. 1981. *Mem. Natl. Inst. Polar Res.* (Tokyo), Special Issue 20: 237-249. [6] Bizzarro et al. 2002. *Geochim Cosmochim. Acta* 66: A79. [7] Blichert-Toft et al., 2002. *Geochim Cosmochim. Acta* 66: A82.

V52B-1294 1330h POSTER

Assessment of Instrumental Mass Bias and Isobaric Interference Corrections for Hf-Lu-Nd Isotopic Geochemistry on Zircon by MC-ICP-MS

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We present (1) a simple approach to correct the mass bias as well as isobaric interferences for Hf-Lu isotopic geochemistry of spiked and unspiked zircon samples, (2) new Lu and Nd isotopic data on the zircon standard 91500, and (3) a new $^{176}\text{Hf}/^{177}\text{Hf}$ reference value on the zircon standard 91500 specific for MC-ICP-MS instruments. The chemical procedure follows that reported previously for determining the Hf isotopic composition in zircon by MC-ICP-MS (Goolaerts et al., AGU, 2001). Potential Hf-Yb-Lu isobaric interferences and instrumental mass bias were investigated by chemical simulations, which were carried out on different mixed standard solutions with variable elemental ratios (Lu/Hf, Lu/Yb, Hf/Yb). All of the data collected from these experiments were then used for iterative modeling of either $^{187}\text{Re}/^{185}\text{Re}$ or $^{176}\text{Yb}/^{173}\text{Yb}$ to optimize the correction procedures.

These experiments highlight the stability of the Nu Plasma MC-ICP-MS with respect to isobaric interferences and complex external normalization. The results also show that instrumental mass bias and strong isobaric interferences due to high Yb/Hf or Yb/Lu ratios are not simply corrected. This is an especially important issue for chemically untreated zircons (i.e. laser ablation studies) or pelagic sediments and Mn-nodes. The instruments were calibrated using standard solutions for Hf (JMC-475 250 ppb: $^{176}\text{Hf}/^{177}\text{Hf} = 0.282161 \pm 16$), Nd (Rennes 300 ppb: $^{143}\text{Nd}/^{144}\text{Nd} = 0.511934 \pm 23$; 50 ppb: $^{143}\text{Nd}/^{144}\text{Nd} = 0.511952 \pm 16$) and Lu (JMC 50 ppb: $^{175}\text{Lu}/^{176}\text{Lu} = 37.72 \pm 2$); all errors are 2sd. The entire analytical method was calibrated by processing 59 Hf measurements on the zircon standard 91500, including four independent complete dissolution procedures and two Nu Plasma MC-ICP-MS instruments (Nu15-ULB, Nu21-UBC). The average $^{176}\text{Hf}/^{177}\text{Hf}$ is 0.282302 ± 8 (2sd) and the Gaussian distribution of our data confirms the absence of systematic analytical error. These high precision data external error: 27.3 ppm (2sd) for 59 measurements and 10 ppm for a single day; internal error: 10 ppm (2sd) show excellent reproducibility between duplicates and underscore the stability of our analytical protocol.

Comparison with published data on the zircon standard 91500 highlights the significant improvement in precision provided by our method and suggests that the previous reference value ($^{176}\text{Hf}/^{177}\text{Hf} = 0.282284 \pm 14$ (2sd), Wiedenbeck et al., *Geostand. Newslett.*, 1995) should be revised for MC-ICP-MS instruments. We have also determined precisely the Lu and Nd isotopic compositions on the zircon standard 91500. With the growing use of in situ measurement techniques using MC-ICP-MS technology, such precise reference values will become critical for the calibration of laser ablation-MC-ICP-MS analyses in the future.

V52C MCC: Hall C Friday 1330h

Osmium and PGEs Posters

Presiding: H Watson, Carnegie

Institution of Washington

V52C-1295 1330h POSTER

A Rhenium-Osmium Study of Sulfides from the Bagdad Porphyry Copper Deposit: Implications for the Duration of Hydrothermal Systems and Source of Metals in Porphyry Deposits

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The timing and duration of hydrothermal systems is one of the remaining issues of central importance to ore geology. The rhenium-osmium (Re-Os) isotopic system has proven to be a useful geochemical tool in not only determining the timing of mineralization but also the long standing question of the source of the ore-forming elements. Here we use Re-Os isotopes to address these fundamental questions in the Bagdad porphyry Cu-Mo deposit.

The Bagdad deposit is composed of a quartz monzonite stock that intrudes Proterozoic (>1.75 Ga) basement rocks. We sampled mineralization (pyrite, chalcopyrite and molybdenite) from the quartz monzonite and porphyritic quartz monzonite units within a zone characterized by moderate to strong potassic alteration (secondary biotite and K-feldspar). We analyzed these samples for Re-Os in order to obtain genetic and geochronologic information. Molybdenite ages provide evidence for two separate mineralization episodes within the Bagdad deposit. The first event occurred at ~76 Ma and a later episode at ~72 Ma. Pyrites have Os and Re concentrations ranging between 8-17 ppt and 3.9-6.8 ppb, respectively. Chalcopyrite samples contain 6 to 12 ppt Os and 1.7 to 4.1 ppb Re; $^{187}\text{Os}/^{188}\text{Os}$ initial ratios range between 0.1 and 0.8. The results presented here support the notion that porphyry-type mineralization is often produced by long-term multiple episodes of magmatism with associated episodic mineralization. The data also agree with previous Pb and Nd isotopes studies and support the hypothesis that a significant part of the metals are derived from a crustal source.

V52C-1296 1330h POSTER

Evolution of Deccan Lavas: Insights From Re-Os Isotopes and Platinum Group Elements

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We are investigating the extent to which crustal fractionation/crustal assimilation has affected the segregation of Platinum Group Elements in Deccan Traps. A series of picrites and basalts from the Deccan Traps were examined for Re-Os isotopes along with PGE contents. The samples cover a range of compositions from picrites with up to 22.4 wt.% MgO to tholeiitic basalts with MgO content down to 6.8 wt.%. The $^{187}\text{Os}/^{188}\text{Os}$ ratios of high MgO samples are 0.1271-0.1274, close to the value of the upper mantle, indicating very little crustal contamination of the primitive samples. The PGE (Os, Ir, Ru, Pt) concentrations are near mantle values for the most primitive picrites and decrease with decreasing MgO and Ni. PGE concentrations in the low MgO samples (<10.2%) are more than an order of magnitude lower than for the lavas with MgO >12.7%, indicating PGE removal by fractionation of olivine and possibly PGE alloys and/or segregation of a sulfide melt between 12.7 and 10.2 wt.% whole rock MgO. The Os/Ir ratio is suprachondritic in the most primitive picrites and decreases with decreasing MgO and becomes subchondritic at around 12.7 wt.% MgO, suggesting a role for Os-Ir alloy nuggets in the fractionation assemblage.

V52C-1297 1330h POSTER

A Comparative Os Isotopic Study of Al-undepleted Komatiites From the Abitibi Greenstone Belt and Ti-enriched Komatiites From the Finnish Lapland

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