such as chlorine, alkalis and strontium that were uptaken during alteration in surface environments close to the seafloor.

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Origin of Deep Crustal Waters in the Hellenic Volcanic Arc (Greece)

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Cold CO_2-rich spring waters, geothermal and hydrothermal waters and fumarolic gases related to the Hellenic Volcanic Arc and deep crustal faults were choosen for full geochemical and isotopic analyses. The water chemistry (including major and trace elements) as well as stable isotope ratios of C, H, O and noble gas isotopic ratios of He, Ne, Ar, Kr, and Xe allow a comprehensive discussion on a mantle or magmatic origin, on the influx of metamorphic, meteoric, seawater, hydrothermal and surface waters. The Hellenic volcanic arc is regarded as a magmatic expression of the still-active subduction of the African plate beneath the Aegean plate, which started around 4 Ma at the beginning of Pliocene. It extends over 600 km from the Volos/Atalanti area to Corinth and Sousaki, Methana, Poros and Aegina islands in the Saronic gulf, to the islands of Santorini and Milos, Kos, Yali and Nisyros in the South Aegean sea. All volcanic fields and islands are associated with major tectonic lineaments and active NE/SW and E/W striking faults. In many cases, cooling magmatic bodies at deeper crustal levels seem to provide the required thermal energy for heating deep circulating water, the generation of hydrothermal systems (e.g. Milos and Nisyros) and ascend to the surface.The temperatures of the thermal waters range from 24°C (Sousaki) to 75°C (Edipsos) and TDS range from 500 ppm to 32 000 ppm respectively. Processes, affecting the water composition, such as mineral-fluid equilibria, mixing, boiling and conductive cooling, have been taken into consideration and calculated. The source regimes of cold mineral, geothermal and hydrothermal waters were discriminated by the use of halogenide ratios of Cl, F, Br and I. Mixtures of seawater and meteoric water could be calculated using δ^2H and $\delta^{18}O$. $\delta^{13}C$ values from bicarbonates show the contribution of metamorphic components through decarbonation of marine sediments as well as biogenic and atmospheric components.Helium, as well as the other noble gases are dissolved mainly in CO_2-rich waters and gases and are accompanied by CH_4 and H_2 emanations. The $^3He/^4He$ ratios of 7.5 to 4.4 x 10^{-6} of the Nisyros fumarolic condensates and of some hydothermal waters from Milos reflect well the high amount of mantle derived primordial ^3He, which in the case of Nisyros, may be related to magma degassing. The lower ratios of 3.4 to 1.6 x 10^{-6} in the hydrothermal waters from Milos and in the Methana thermal springs represent a mixing with radiogenic ^4He due to crustal contamination during ascent of primordial ^3He through the crust.

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Evaporite is an Important Boron Source for B-Rich Granites and Pegmatites

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Magmatic volatiles-water, halogens, phosphrous, and boron-are of great importance in the generation and evolution of granitic magma. The existence of boron in melt can significantly reduce liquidus and solidus temperatures, decrease viscosity, and increase the solubility of H_2O, and thus modify the melt properties. Boron may also affect the fractionation of other petrologically and economically important metals in the melt. However, the origin of boron in the magmatic systems is still a matter of great debate. Tourmaline has a wide P-T stability and can persist in metasedimentary rocks at least up to anatexis conditions. Therefore, it has been suggested that tourmaline represents a most likely reservoir of B for S-type granitic magmas. Most common rock-forming silicate minerals contain only minor to trace amounts of B (up to several hundred ppm in muscovite, for example), but their high modal abundance may still make them as a significant B inventory for granitic magmas. Evaporites, especially non-marine evaporites, contain high concentrations of B, and are therefore potentially important boron sources, in particular for those extremely high-B granites and pegmatites. However, previous studies have not yet obtained conclusive data to support this hypothesis as evaporites are extremely soluble and not readily preserved in the geologic record.

Boron isotope composition is a relatively new geochemical tool to trace the source of boron. The $\delta^{11}B$ values of the major reservoirs of boron are well characterized. Of particular interest is the large difference in $\delta^{11}B$ values between marine and non-marine evaporites (+18 to +32‰ and -30 to +10‰, respectively). In this paper, I report $\delta^{11}B$ data for several B-rich granites and pegmatites from the Czech Republic. The very low $\delta^{11}B$ values (-15 to -36‰) in the studied granitic and pegmatitic tourmalines provide strong evidence to support derivation of boron from non-marine evaporites, either in the source regions or during ascent of the magma. Non-marine evaporites are the only boron reservoir known in nature with an $\delta^{11}B$ value less than -20‰. There is an overlap of $\delta^{11}B$ values between most crustal rocks and the upper data range of non-marine evaporites (0±10‰). Hence, it is possible that many B-rich granitic bodies with higher $\delta^{11}B$ values (around -10‰) such as Cornwall granites in SW England may also have non-marine evaporites as a major source for their boron.

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Fluid Exchange between the Lower Continental Crust and Upper Mantle

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Situated at the interface between the continental crust and the mantle, the lower continental crust is a complex domain where a number of fluid/melt/mineral interaction processes take place. A limited number of fluid types are repeatedly observed in all lower crustal segments now exposed at the Earth's surface. Composition, possible source and transport pathways of these fluid types, have been documented by fluid inclusion and stable isotope studies. They are represented by high density gases (mainly CO_2), to a much lesser extent N_2 and other species) and aqueous solutions of variable salinity (mainly high-salinity brines).

The nature of dominant fluids and the scale of fluid transport appear to be essentially controlled by the maximum pressure reached during peak metamorphic conditions. In eclogites, fluids are dominantly aqueous with very variable salinities, more rarely gaseous (N_2 dominant) (Nadeau et al., 1993). These fluids are internally generated during the prograde metamorphic evolution, resulting in a limited amount of fluids of variable composition in crystal-size domains. On the contrary, large quantities of fluids with a relatively constant composition (CO_2 and high-salinity brines) are generated in granulites, due to the increasing importance of partial melting in granulites (from high- toward low-pressure), as well as the systematic occurrence of synmetamorphic intrusives (especially in high-temperature granulites) (Touret & Huizenga, 1998). These fluids are able to percolate on rather large distances along channelized pathways.

Detailed discussion of a number of occurrences in former Gondwana lands such as Madagascar, India and Sri-Lanka (Bolder-Schrijver et al., submitted) indicate that most CO_2 is mantle-derived, transported in the lower crust by CO_2-saturated melts of variable composition (silicate and carbonate).

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Solubility and Diffusivity of Noble Gases in Synthetic Phlogopite: An UVLAMP Investigation

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Noble gas partitioning between crystalline phases and melts is a prerequisite to understanding terrestrial outgassing. Knowledge of the partition coefficient requires analyses of the solubility in both crystal and melt. Solubilities in melts are now well known, whereas solubility in minerals is very low and mechanisms are not well understood. Since bulk analytical methods tend to overestimate partition coefficients (Roselieb et al., 1997; Brooker et al., 1998), we have employed the UV laser ablation microprobe (UVLAMP), a sensitive method with high spatial resolution for noble gas analysis. We used this method to determine simultaneously the solubility and diffusivity of noble gases in a synthetic iron-free F-phlogopite, which was synthesised by Hammouda et al. (1995). Moreover, knowledge of the diffusivity of Ar in K-bearing minerals is needed in order to evaluate if K-Ar or Ar-Ar techniques yield reliable geochronological information.

Pt-capsules were filled with single grains of the sample and the noble gas (pure Ne, Ar or a mixture of 35% Ne, Ar and 10% He, Kr, Xe) and welded closed following the method of Boettcher et al. (1989). The capsules were run in an internally heated pressure vessel. Experiments with Ne and Ar were performed at a pressure of 6 kbar and temperatures of 1200°C and 1300°C for 24 h. During the Ar-analyses both surface layer and cleavage effects were encountered and Ar concentrations up to 600 ppm were detected from these regions. These effects were avoided by removing the top surface layer and controlling the laser power and ablation rate so as not to ablate an underlying cleavage trace. Profiles were analysed, perpendicular to the cleavage traces (after removal of the surface layer), along two approximately 400 x 200-250 μm long and 2 μm deep traverses. From the measured Ar profiles the diffusion coefficient can be calculated employing the solution for radial diffusion in a cylinder (Crank, 1975) yielding a diffusivity of 1.6x10^{-9} and 1.1x10^{-9} cm^2/s at 1300°C. The solubility of Ar, which is represented by the surface concentration, can be calculated from the profiles and yields a value of 11 ppm. Using the Arrhenius-parameters of the bulk analysis from Giletti (1974), an extrapolation to 1300°C yields a diffusivity of 6.9x10^{-9} cm^2/s, which is in reasonable agreement with our results. Assuming that the solubility obeys Henry's law, an Ar partition coefficient can be estimated. For phlogopite an argon solubility of 0.0018 ppm/bar was calculated. This solubility can be compared to the Ar solubility in an ultrabasic potassium rich melt (e.g., leucite-basanite or ugandite) in equilibrium with phlogopite. Ar solubilities in these melts at 1350°C range from 0.22 to 0.08 ppm/bar (Lux, 1987). The comparison yields an estimate of the partition coefficient ranging from 0.008 to 0.02.

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