The evolution of magmas at a large stratocone volcano, Mount Shasta, N. California

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Mount Shasta, the largest stratovolcano in the Cascade volcanic arc, has been rebuilt since a major sector collapse in at least four major cone-building stages since ~300 ka [1,2]. In conjunction with earlier elemental and isotopic studies [3,4,5,6,7], new Sr, Nd, and Pb isotope data reported here, as well as in-progress U-Th isotope studies, document mantle and crustal contributions to magmas at Mt. Shasta.

The dominantly andesitic Mt. Shasta lavas are characterized by Sr, Ba, Th, Rb and Pb enrichment, depletions in Nb, Ta and HREE, and MORB-like Sr isotopic ratios. Major element modelling is consistent with fractional crystallization of an arc basalt type parent. However, incompatible element enrichments in the lavas 2–3 times higher than predicted by this model preclude magmatic evolution by fractional crystallization alone. Elevated Rb and Ba in other southern Cascade volcanoes are attributed to crustal contamination [6], which may also account for similar enrichments in the Shasta lavas. U-Th isotope data indicate Th enrichment [8] that may be explained by production of garnet in the lower crust via dehydration melting of amphibole.

Sr, Nd, and Pb isotopes indicate a blend of crust and mantle components. $^{87}Sr/^{86}Sr$ ratios vary from 0.7027 to 0.7035 and ε_{Nd} values range from +4 to +6. These compositions are more mantle-like than at Lassen Peak, although they extend to more crust-like compositions than primitive central Cascade lavas. $^{206}Pb/^{204}Pb$-$^{207}Pb/^{204}Pb$ variations form a tight linear array between Juan de Fuca/Gorda Ridge MORB and Cascade region upper crust, a trend that could reflect a subduction component or interaction with the crust. Upper crustal assimilation, however, fails to account adequately for all trace element and isotopic data, providing support for an important lower-crustal role. Evidence for a significant slab contribution comes from trace-element and isotopic variations: high $(Sr/P)_n$ lavas have Sr and Pb enrichments, large Nb and Ta depletions, and Juan de Fuca MORB or slab-like Sr and Pb isotopic ratios; low $(Sr/P)_n$ lavas have more radiogenic Sr and Pb isotopic ratios and lower $^{143}Nd/^{144}Nd$ ratios, similar to OIB, or a mantle like component [6]. Thus, magmatic evolution at Mt. Shasta involves fractional crystallization of an arc basalt type parent, variable slab-fluid influence, and potential assimilation of lower crust, but relatively little upper crustal assimilation. Many of the older lavas have more radiogenic Sr and Pb but non-radiogenic Nd, suggesting greater crustal assimilation in the early history Mount Shasta, reflecting evolution of the conduit system.

[1] Christiansen *et al.* (1977) US Geol Surv, 77-250. [2] Calvert and Christiansen (2010) AGU Abstract. [3] Baker (1988) PhD Thesis [4] Baker *et al.* (1994) *Cont Min Pet* **118**, 111-129. [5] Grove *et al.* (2002) *Cont Min Pet* **142**, 375-396. [6] Borg *et al.* (1997) *Can Mineral* **35**, 425-452. [7] Bacon *et al.* (1997) *Can Mineral* **35**, 397-423. [8] Newman *et al.* (1986) *Cont Min Pet* **93**, 195-206.

Tire-wear particles and their impact on human lung cells

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In the recent literature, there has been a debate about the real properties of tire-wear particles, especially concerning their size and chemical composition but also with respect to their effects on human health. The aims of this study, therefore, were to characterize tire-wear particles using geochemical and mineralogical techniques and to evaluate the toxicological properties of these particles. Another important goal was to develop standard experimental procedures, which lead to representative results.

Samples of tire-wear particles were produced in a standardized tire-test rig, which allowed for collection of particles from three different types of car tires. In addition, one pure-tire sample was obtained by grinding shredded scrap car tires. These four samples were characterized by using scanning electron microscopy (SEM) and optical microscopy with an associated image analysis system (IAS) in order to determine size distribution, chemical composition, particle structure, and optical properties. The investigations of the different samples indicated that a large fraction of particles have equivalent diameters <10 µm with distinct size distributions for the different samples. All samples contained particles smaller 5 µm. IAS showed that all samples contained both opaque and transparent particles. Usually only the opaque particles are regarded as tire material, whereas the transparent particles are assumed to originate from the pavement material. The amount of transparent particles can be used to trace impurities in the tire samples but a certain fraction also seems to originate from the tires themselves.

Subsequently, the tire-wear and tire particles were investigated in terms of their toxicity and their inflammatory effects on human lung cells (from the commonly used lung cell line A549). The experiments have shown that the lung cells, which were exposed for up to 8 h to various concentrations of particles in suspension between 5 and 50 µg/cm², did not show any increase in NF-κB-DNA binding activity. An exception is one sample, for which an 8 h exposure to 50 µg/cm² sample material, led to a stronger increase in NF-κB-DNA binding activity as measured by electrophoretic mobility shift assays (EMSA). The activation of the transcription factor NF-κB in cells is closely linked to inflammatory processes. The cytotoxicity tests revealed an increased cytotoxic potential for all samples from the tire-test rig but not for the pure-tire material. The extent of cytotoxicity, as measured by MTT-tests, varies with concentration. Whereas cytotoxicity was only slight for various particle concentrations, one sample induces cytotoxicity up to about 50%.
The question of the critical role played by size rather than chemical composition of the tire particles will be studied further.