

## Styles of interaction between mafic magma and continental crust

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Geologists have long recognized that ascending mantle-derived mafic magmas are changed in composition by passage through the crust. The evidence for assimilation of crust is particularly clear in the case of continental volcanic fields where strong trace element and isotopic contrasts exist between magma and regional crust. The advent of routine trace-element and isotopic microanalysis in the past decade has shown that some of these interactions occur during phenocryst growth on timescales of <10 to >1000 years, and that mafic magmas may be erupted while still in the process of assembly from different source components. The thermal state, age and composition of the contaminating crust are important parameters that largely determine the imprint of the contamination processes on the final erupted basalt. This contribution will explore different styles and consequences of magma-crust interaction using examples from the Jemez Mountains volcanic field (JMVF), the main phase of the Columbia River basalts, and elsewhere. The JMVF is the product of prolonged, pulsating, overall low-flux (~0.15 km<sup>3</sup>/ka) volcanism associated with lithospheric extension; almost all lavas bear a strong crustal imprint. Major shifts in the location, style and geochemical character of JMVF magmas occur within a few million years after volcanic maxima and may correspond to pooling of mantle-derived magma at new locations in the crust. In contrast, the high-flux (~300 km<sup>3</sup>/ka) main phase Columbia River lavas show evidence of a dramatic sudden change in the degree and style of magma-crust interaction at a sharp stratigraphic boundary at the base of the Grande Ronde Basalt; the timescale of this transition is unknown but is unlikely to be >10<sup>4</sup> years.

## Barium, but no Sr isotope anomalies in carbonaceous chondrites

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To further evaluate the distribution of nucleosynthetic isotope anomalies in bulk solar system samples, precise Ba and Sr isotope compositions were determined by TIMS in chondrites (Murchison CM2, Allende CV3, Kainsaz CO3, Forest City H5, St. Severin LL6) and a HCl leachate from Murchison. Of the bulk samples, only the carbonaceous chondrites display slight enrichments in the r-process dominated nuclides <sup>135</sup>Ba and <sup>137</sup>Ba. The HCl leachate from Murchison shows a much larger r-process isotope excess of 249, 136 and 59 ppm for <sup>135</sup>Ba, <sup>137</sup>Ba and <sup>138</sup>Ba, respectively. None of the samples displays resolvable anomalies for the rare p-only nuclides <sup>130</sup>Ba and <sup>132</sup>Ba, outside the external reproducibility of 175 and 104 ppm (2 sd). Stable Sr isotopes in Allende and Murchison (bulk and HCl leachate) display normal compositions within 49 ppm (2 sd; <sup>86</sup>Sr/<sup>88</sup>Sr rel. to <sup>84</sup>Sr/<sup>88</sup>Sr). The above Ba and Sr isotope data are in accord with previous data by [1-3].

Discussion and conclusions: Testruns using a containerless laser fusion method [4] indicate that the anomalies do not result from incomplete sample digestion. The Murchison HCl leachate shows that the anomalous Ba resides in chemically labile carrier phases and that Sr is either not abundant in these phases or isotopically normal. This is remarkable, since Ba and Sr feature a similar condensation temperature and chemical behaviour and may imply that the production of Sr and Ba r-process isotopes is decoupled. Also, Ba and Sr p-process isotopes are normal and apparently decoupled from Sm isotopes [5]. Carbonaceous chondrite leachates display large isotope anomalies in the refractory elements Ba, Mo, Zr, Os [1, 6, 7, 8], that are (nearly) balanced in the bulk samples. This requires that dust in the carbonaceous chondrite source region was never completely vaporized.

[1] Hidaka *et al.* (2003) *EPSL* **214**, 455-466. [2] Carlson *et al.* (2007) *Science* **316**, 1175-1178. [3] Andraesen & Sharma (2007) *Astrophys. J.* **665**, 874-883. [4] Pack *et al.* (2007) *GCA* **71**, 4592-4608. [5] Andraesen & Sharma (2006) *Science* **314**, 806-809. [6] Dauphas *et al.* (2002) *Ap. J.* **569**, L139-L142. [7] Schönbächler *et al.* (2005) *GCA* **69**, 5113-5122. [8] Yokoyama *et al.* (2007) *EPSL* **259**, 567-580.