

## Not much gabbro in the Icelandic mantle!

MATTHEW THIRLWALL<sup>1</sup> AND MARY GEE<sup>2</sup>

<sup>1</sup>Geology, Royal Holloway University of London, Egham TW20 0EX, UK. (m.thirlwall@gl.rhul.ac.uk)

<sup>2</sup>Earth and Geographical Sciences, Univ. Western Australia, Crawley WA 6009. (mgee@cyllene.uwa.edu.au)

Picritic lavas from Iceland have unusual trace element signatures, including strong incompatible element depletion, that have been used to infer derivation from a source dominated by oceanic gabbros, either through deep ancient recycling [e.g. 1] or shallow recent recycling [2]. We report results of a multi-element MC-ICP-MS isotope dilution study of lavas from the Reykjanes Peninsula that include depleted lavas ('picrites' *s.l.*) from 14 separate localities, with the aims of testing the recycled gabbro hypothesis and constraining the timing of incompatible element depletion.

The key features that have been attributed to a gabbroic source are positive anomalies for Sr, Ba and Eu, relatively low Ce/Pb, and negative anomalies for Zr and Hf. We would also expect  $Dy/Yb_N > 1$  due to melting clinopyroxene that had crystallized from liquids with flat HREE patterns. Sr/Nd, Sm/Zr and Pb/Ce increase systematically with increasing LREE depletion, consistent with reported anomalies in depleted lavas. However, Sr/Sm is essentially constant across the full spectrum of LREE enrichment, while Nd/Zr and Pb/Nd decrease systematically with LREE depletion. This suggests that the reported anomalies are substantially due to incorrect assumptions about the REE  $K_D$  analogues for Sr, Zr and Pb.  $Eu/Eu^*$  increases from about  $1.03 \pm 0.02$  in LREE-enriched lavas to  $\sim 1.08$  in the most LREE-depleted lavas, an increase at least in part due to the strong concave-down curvature in depleted lava REE patterns. Most depleted lavas show  $Dy/Yb_N < 1$ , inconsistent with large-degree melting of gabbro-dominated sources, and suggesting that their sources are simply produced by extensive melt extraction from normal Icelandic mantle sources in the garnet facies. Their more depleted isotopic compositions may largely reflect the time elapsed since this melt extraction, at most 270 Ma. Tight coupling between Lu/Hf and Sm/Nd, but not between these and Hf or Nd isotope ratios, also requires a dominant control by melt extraction on the incompatible element depletion.

Depleted lavas from the BIR1 locality, and maybe one other, show strongly elevated Sr/Sm, Nd/Zr, Ba/La and Ba/Rb;  $Eu/Eu^* > 1.1$  and  $Dy/Yb_N > 1$  despite similar LREE depletion to many other Reykjanes lavas. So the famed Icelandic recycled gabbro signature is only clear in one  $\sim 200$ m location, made famous because of an international reference sample! Compared with most other LREE-depleted lavas, these have low  $\delta^{18}O$  (ca. +4.5‰), and also low  $^{143}Nd/^{144}Nd$  and  $^{176}Hf/^{177}Hf$  for their Sm/Nd and Lu/Hf. These suggest that most of their LREE-depletion has only been generated in the last  $\sim 60$ Ma.

[1] Chauvel and Hemond (2000). *G<sup>3</sup>*. **1**, 1525-2027

[2] Foulger, Natland & Anderson (2005). *J. Volcanol. Geotherm. Res.* **141**, 23-44.

## Mineralogical investigation of fly ashes of the electricity power stations of the Ptolemais - Amynteon district (Greece)

S. THOMAIDIS, G. KOSTAKIS AND A. STRATAKIS

Technical Univ. of Crete, Dept. of Mineral Resources Engineering, Gr-73100 Chania, Greece (kostakis@mred.tuc.gr)

Fly ashes were examined, those in one period of approx. 3 months of altogether six boilers from four electricity power stations (Agios Dimitrios, Kardias, Ptolemais and Amynteon, Greece), which are fired with lignite of the Ptolemais-Amynteon-basin. From each fly ash the size fractions of  $> 71 \mu m$ ,  $71 \mu m$  to  $20 \mu m$ ,  $20 \mu m$  to  $2 \mu m$  and  $< 2 \mu m$  are mineralogical by Roentgen-diffractometry (RIETVELD method), as well as chemically by Roentgen fluorescence were analyzed.

It is shown that the examined fly ashes of the power stations of Agios Dimitrios, Kardias, and Ptolemais, have, essentially, the same qualitative mineralogical composition (anhydrite, lime, periclase, gehlenite, brownmillerite,  $Ca_2SiO_4$ , calcite, quartz, feldspare, muscovite/illite, hematite, amorphous phase and  $\pm$  merwinite, and/or mayenite). Also their quantitative mineralogical composition is similar. Compared the ashes of the above three power stations with the fly ashes of the power station of Amynteon show only a relative little difference of the qualitative composition (anhydrite, lime, periclase, gehlenite, brownmillerite,  $Ca_2SiO_4$ , calcite, quartz, feldspare, muscovite/illite, hematite, pyroxene, hercynite and amorphous phase) but different quantitative phase composition, owing mainly to a differentiated relationship between the  $SiO_2$  and CaO content.

The main part of the mass of the fly ashes constituted the grain size fractions  $> 71 \mu m$ ,  $71 \mu m$  to  $20 \mu m$  and  $20 \mu m$  to  $2 \mu m$ , since the grain size fractions  $< 2 \mu m$  in all samples constitute less than 0.2%.

In all fly ashes by decreasing grain size was determined, on the one hand an increasing of the  $CaSO_4$  content and on the other hand, excepting a few cases, a decreasing of content of the amorphous phase, of quartz as well as feldspare and/or the pyroxene. Beyond by the grain size fractions  $< 71 \mu m$  an increasing of the contents of gehlenite, brownmillerite,  $Ca_2SiO_4$  and, in the most cases, calcite were observed.

It was shown that the contents of the amorphous phase (glass phases, unburned lignite), as well as of the not reacted silicates by burning of the lignite, decrease by the smaller grain sizes, while the crystalline, mainly calcium-rich, phases which are formed when burning, in the grain size fraction  $< 71 \mu m$  of the fly ashes are enriched.