

## New Basaltic and Solution Reference Materials for Iron, Copper and Zinc Isotope Measurements

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The iron (Fe), Copper (Cu) and Zinc (Zn) stable isotope systems have been applied to constrain a variety of geochemical and environmental issues. Three reference solutions named CAGS-Fe, CAGS-Cu and CAGS-Zn, and one basalt reference materials named CAGSR for use as Fe, Cu and Zn isotope ratio measurements have been developed by the Institute of Geology, Chinese Academy of Geological Sciences (CAGS), in collaboration with other participating laboratories. CAGS-Fe, CAGS-Cu, CAGS-Zn and CAGSR show sufficient homogeneity and stability. Recommended reference values were determined by inter-laboratory comparison of results from participating laboratories (CAGS-Fe, 8 participating laboratories; CAGS-Cu, 6 participating laboratories; CAGS-Zn, 7 participating laboratories; CAGSR-Fe, 6 participating laboratories; CAGSR-Cu, 5 participating laboratories; CAGSR-Zn, 4 participating laboratories) using MC-ICP-MS, and calculated from the unweighted means of the results submitted by the participating laboratories. Fe, Cu and Zn isotopic data are reported in per mil using standard  $\delta$ -notation. Fe, Cu and Zn isotope values are relative to IRMM-014, SRM 976 and IRMM-3702, respectively. The reference values are given as following:  $\delta^{56}\text{Fe} (\text{‰})_{\text{CAGS-Fe}} = 0.83 \pm 0.06$ ,  $\delta^{57}\text{Fe} (\text{‰})_{\text{CAGS-Fe}} = 1.20 \pm 0.12$ ;  $\delta^{65}\text{Cu} (\text{‰})_{\text{CAGS-Cu}} = 0.57 \pm 0.05$ ;  $\delta^{66}\text{Zn} (\text{‰})_{\text{CAGS-Zn}} = -0.79 \pm 0.12$ ,  $\delta^{68}\text{Zn} (\text{‰})_{\text{CAGS-Zn}} = -1.65 \pm 0.24$ ;  $\delta^{56}\text{Fe} (\text{‰})_{\text{CAGSR}} = 0.15 \pm 0.05$ ,  $\delta^{57}\text{Fe} (\text{‰})_{\text{CAGSR}} = 0.22 \pm 0.05$ ;  $\delta^{65}\text{Cu} (\text{‰})_{\text{CAGSR}} = 0.12 \pm 0.07$ ;  $\delta^{66}\text{Zn} (\text{‰})_{\text{CAGSR}} = 0.17 \pm 0.11$ ,  $\delta^{68}\text{Zn} (\text{‰})_{\text{CAGSR}} = 0.34 \pm 0.21$  (2sd). CAGS-Fe, CAGS-Cu and CAGS-Zn are good choices to be reference standards for Fe, Cu and Zn isotope determinations because of their offset values from zero-delta, their homogeneity and stability and can be used for instrumental calibration and training of analysts. CAGSR can be used to validate chromatographic separation and total measurement procedure as well as and long-term repeatability of mass spectrometry performance, and enable inter-laboratory comparisons.