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Non-traditional isotopic variations in the Rochechouart impact structures: tracers of melting, mixing, volatilization and hydrothermal alteration.

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The impact structure of Rochechouart (North-West of the French Massif Central, 40 km West of Limoges, France) is a deeply eroded crater located on crystalline metamorphized gneiss and granites from the Hercynian Massif Central, which formed 206.92 +/- 0.32 Myr ago. A drilling campaign was organized in 2017 by the Centre for International Research and Restitution on Impacts and on Rochechouart (CIRIR) to sample the full range of impactites across the structure. Twenty-two samples from 6 drilling sites have been selected for non-traditional stable isotope analyses, based on prior petrographic and geochemical studies. The iron, copper, zinc, and germanium isotope systems, covering a range of volatility behaviour, were used to study the effects of melting, mixing and volatilisation on the produced impactites, while also allowing to trace the effects of post-impact hydrothermal alteration.

The Ge isotope results, acquired at CRPG-Nancy, represent the first-ever data obtained within an impact structure. They display large variations in $\delta^{74/70}$Ge values (ranging from ~ 0.1 to 1‰) and plot in two groups, distinct from the basement samples (Figure). Impactoclastites, suevites and a single breccia typically exhibit similar Ge concentrations as the basement samples but at higher $\delta^{74/70}$Ge isotopic signatures. Most impact melt rocks and a single breccia sample display Ge isotopic signatures comparable or lower relative to the basement samples, but at higher Ge elemental concentrations. These results imply at least two distinct processes affecting these drill core samples: (1) the heavy $\delta^{74/70}$Ge isotopic signatures in Group 1 possibly reflect impact-induced volatilization and mixing with the meteoritic component, (2) while the Group 2 signatures may reflect superimposed secondary hydrothermal alteration. The first Fe analyses indicate variations in $\delta^{57/54}$Fe between -0.39 and 1.00‰. Cu and Zn isotope data are currently being collected for the same samples. This multi-isotopic approach will constrain the geochemical and isotopic signatures of the various lithologies of the Rochechouart impact structure and will further help to trace and refine the nature of these syn- and post-impact processes, meteoritic contribution, and hydrothermal alteration.