Internship position @ CRPG & CEREGE / Stage de recherche Master 2

Origins of aubrite meteorites: paleomagnetic study

Context: This internship is part of the IMPAcToR project led by Camille Cartier, funded by the ANR for the period 2025-2029. This project aims at unraveling the link between aubrites meteorites, planet Mercury, and E-type asteroids through a multi-disciplinary approach.

Internship supervisors: Camille Cartier (CRPG, Nancy), Julien Charreau (CRPG, Nancy), Jérôme Gattacceca (CEREGE, Aix-en-Provence)

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Scientific domains: Planetary Science, Paleomagnetism, Meteoritics, Modeling

Expected start date and duration: 5-6 months starting January 2026

Location: This internship will be hosted at CRPG (Nancy) and will include 1 to 3 months stay in CEREGE (Aix-en-Provence).

Application deadline: Applications will be accepted until the position is filled

Application process: Candidates should contact the three supervisors with a cover letter and a CV

Desired profile: Candidates should be in the final year of a Master's degree, ideally in Geosciences or Planetary Science. Candidates should be highly motivated by the study of meteorites, with solid knowledge in petrology, physics, and an excellent level of written expression. Knowledge of cosmochemistry is a plus, as well as experience with the methods that will be used.

Summary: Mercury stands out as an outlier in our Solar System, characterized by its unique lithologies formed in an ultra-reducing, sulfur-rich environment (Cartier and Wood 2019). Despite being the smallest planet, Mercury intriguingly has the largest core proportionately (Cartier et al. 2020). Thus, a long-standing hypothesis suggests that Mercury originally had a much larger rocky mantle, largely pulverized during massive impact(s). However, due to insufficient constraints, this scenario has never been confirmed and the origin of Mercury remains a highly elusive and debated topic. Aubrites, rare achondrites with mineralogies particularly similar to that of Mercury, are known to originate from E-type asteroids, small "rubble piles" located in the innermost asteroid belt. The present project aims to evaluate the original hypothesis according to which aubrites would be remnants of the shallow mantle of a large proto-Mercury, pulverized by one or more giant impacts, and of which a small fraction of the debris would have been implanted in the asteroid belt in the form of E-type asteroids.

Paleomagnetic studies of meteorites have shown that during their early history, a number of differentiated planetesimals have generated magnetic fields by dynamo effect powered by convection in their liquid metallic core (Gattacceca and Rochette, 2004; Fu et al. 2012). Larger bodies, like Mars and the Moon, have sustained dynamos for hundreds of Myr and even for several Gyr. Mercury is an interesting case of a relatively small planet, although with a large core, that still powers a weak dynamo. If aubrites originate from a large proto-Mercury, they should have recorded the hermean magnetic field

while they were cooling between about 700 and 400°C, the blocking temperature range of their main ferromagnetic mineral kamacite. The paleomagnetism of aubrites has been only very little studied, and these studies are clearly outdated (Gattacceca and Rochette, 2004).

In this project we will conduct a paleomagnetic study of a selection of aubrites under the guidance of J. Gattacceca, benefiting from the conceptual and analytical advances in meteorite paleomagnetism that have been made in the last 15 years in particular at the Rock Magnetism laboratory in CEREGE. Samples will be pre-selected by conducting preliminary measurements in the Paleomagnetism and Magnetic susceptibility platform at CRPG.

Methods: Paleomagnetic measurements, modeling