Internship position @ CRPG (Nancy, France) / Stage de recherche Master 2

Origins of aubrite meteorites: Al-Mg and Mn-Cr in-situ dating

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 and Johan Villeneuve (CRPG, Université de Lorraine, Nancy)

Contact: camille.cartier@univ-lorraine.fr

Scientific domains: Planetary Science, Cosmochemistry, Igneous Petrology, Geochemistry

Expected start date and duration: 4-5 months starting January 2025

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

Application process: Candidates should contact Camille Cartier 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 and geochemistry, and an excellent level of written expression. Knowledge of cosmochemistry is a plus, as well as experience in one or more of the analytical methods that will be used.

PhD opportunity: There will a possibility for the student to continue with a PhD thesis after the internship. The PhD will involve the comprehensive petrological and geochemical characterization of a unique collection of aubrites and other related meteorites in the aim of modeling the geological history of their parent body and understanding its link with planet Mercury.

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. Supported by geochemical arguments (Cartier et al. 2022, 2023), this hypothesis will be tested here by carrying out the first in-situ dating study of aubrites, providing new strong constraints supporting or refuting the proposed scenario, and allowing in both cases to reconstruct the history of the parent body of the

aubrites, from its formation 4.6 billion years ago to its dislocation at the origin of the fall of aubrites on Earth.

The aim of this project is to perform the first in-situ dating of aubrites using ^{26}Al-^{26}Mg and ^{53}Mn-^{53}Cr systematics, taking advantage of an equipment almost unique in the world at CRPG, and allowing us to measure high resolution ages in small phases (Villeneuve et al. 2009; Piralla et al. 2023). By measuring the first individual ages of various silicate and sulfide minerals in many meteorites, we will be able to construct the first thermal evolution model of the aubrite parent body, with possible connection to Mercury's early thermal history.

Methods: SIMS, EPMA, SEM-EDX