Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.4955

In-situ Lu-Hf and Pu fission track dating of pallasite meteorites

THOMAS BURKE, STIJN GLORIE, MARTIN HAND, ALEXANDER SIMPSON, SARAH GILBERT AND BENJAMIN WADE

The University of Adelaide

Presenting Author: thomas.burke@adelaide.edu.au

Pallasites are stony-iron meteorites that are generally accepted to have originated from the core-mantle boundary of a planetesimal. Few pallasite formation ages have been constrained by whole-rock Re-Os and phosphate Pu fission track dating, which both involve destructive sample preparation and challenging analytical processes (e.g. irradiation at a nuclear facility for fission track dating). Given that only few absolute age determinations exist, it is currently uncertain if the ~130 pallasite meteorites that have been discovered on Earth were sourced from a single planetary body, or multiple planetoids. We have developed a new analytical workflow using µXRF, SEM and LA-ICP-MS/MS that allows in-situ Lu-Hf and Pu fission track dating of phosphate crystals from a polished section of pallasite samples. The main advantages of the approach are: (1) no destructive sample preparation requirements, (2) high spatial resolution and (3) large quantities of data can be collected in a short time span. Fission tracks were analysed using reflective light microscopy and SEM imaging and corrected for contributions from ^{238}U by in-situ measurement of U concentrations. Cosmic ray tracks were visually distinguished from the fission tracks and discarded to calculate ^{244}Pu fission track ages. Elevated Ytrrium concentrations were detected using µXRF imaging as a proxy for targeting Lu-rich zones in the phosphate grains. Using innovative mass-filtering procedures in an Agilent 8900 reaction-cell mass spectrometer, high order reaction products of ^{176}Hf, ^{175}Lu and ^{178}Hf were measured free from isobaric interferences. ^{175}Lu and ^{178}Hf were measured as proxies for ^{176}Lu and ^{177}Hf, respectively. The resulting isotopic ratios of ^{176}Hf/^{177}Hf and ^{176}Lu/^{177}Hf were used to compute Lu-Hf ages. The technological innovation, involving two radiometric clocks, enables the ability to rapidly obtain age information for a large range of pallasite (and potentially other rocky meteorite) samples, with an aim to enhance our understanding of the early evolution of the solar system.