Comet 81P/Wild 2 dust versus cometary interplanetary dust

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Samples returned by the Stardust mission from Comet 81P/Wild 2, believed to originate in the Kuiper Belt, were expected to include materials found in chondritite porous interplanetary dust particles (CP IDPs), collected in the stratosphere, since much of this latter dust population derives from cometary bodies. Some CP IDPs are highly enriched in presolar grains, isotopically anomalous grains inherited from the interstellar medium and presolar molecular cloud, and Wild 2 was anticipated as a reservoir of presolar material. A search in Stardust samples for the most recognizable and most abundant silicate materials in CP IDPs has, to date, turned up empty-handed [1]. A single enstatite whisker (readily identifiable in CP IDPs) is reported in the returned Wild 2 sample but with crystallographic orientation inconsistent with those in CP IDPs. Objects like GEMS (which are abundant in CP IDPs and include verified presolar amorphous silicates) are found in abundance in the returned sample; however, we have demonstrated their creation on capture by impact of pyrrhotite into silica aerogel at Stardust speeds.

The lack of enstatite whiskers and recognizable GEMS, combined with existing evidence of characteristic inner solar system refractory materials, low D/H ratios, and a dearth of presolar grains and refractory carbon, indicate indigenous outer nebula material is probably rare in 81P/Wild 2. Instead, the returned sample resembles materials in chondritic meteorites re-emphasizing the petrogenetic continuum between comets and asteroids and raising questions concerning early solar system transport and small solar system body classification. CP IDPs remain an invaluable source of cosmically primitive material.

We acknowledge NASA and JPL/Caltech for substrates and NASA, STFC and LLNL SEGRF for funding. Portions of this work performed under U.S. DOE auspices by LLNL under contract DE-AC52-07NA27344.

[1] Ishii *et al.* (2008) *Science* **319,** 447-450.

Integrated thermal history analysis of the Beaufort-Mackenzie basin using multi-kinetic apatite fission track thermochronology

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Sixty apatite fission track (FT) samples (mainly cores from Cenozoic, Cretaceous and Devonian rocks) were collected from twenty-five petroleum exploration wells distributed across the Beafort-Mackenzie Basin (BMB), northern Canada, as part of an integrated study of petroleum systems. In addition, vitrinite reflectance and shale compaction data were obtained to help constrain maximum paleotemperatures and erosion magnitudes. Sample apatite grains are heterogeneous in composition and yield mixed FT age populations. Older age grains have elevated concentrations of elements (e.g. Fe, Mg, Mn, Cl) that make them more FT retentive (higher annealing temperature) than typical fluorapatite. Elemental data were used to calculate r_{mr0} values [1] corresponding to apatite populations with different FT annealing kinetics. FT age populations determined using the r_{mr0} parameter show good agreement with those derived using the binomial peak-fitting program, BINOMFIT [2]. In general, the r_{mr0} parameter produced more consistent and better defined kinetic populations than other commonly used parameters (e.g. Cl content, FT etch figure size).

Thermal histories were obtained for the FT samples using an inverse Monte Carlo model [3] incorporating the multi-kinetic FT annealing scheme of Ketcham *et al*. [1] that treats each kinetic population in a sample as a separate thermochronometer, thus enhancing thermal history resolution. Model solutions are consistent with observed FT age and length parameters and conform to other geological constraints (present temperature, thermal maturity, rate bounds from preserved stratigraphy). The multi-kinetic FT samples constrain both the post-depositional heating and cooling histories of the Cretaceous-Cenozoic sedimentary successions comprising the BMB as well as the cooling histories of the exhumed source areas from which these sediments were derived.

[1] Ketcham *et al*. (1999) *Am. Min.* **84**, 1235-1255. [2] Brandon (2002) *On Track* **24**, 13-18. [3] Issler *et al.* (2005) *Bull. Can. Petr. Geol.* **53**, 405-431.