Shock heating origin of anomalous achondrite NWA 6704 from infrared spectroscopy and modal mineralogy

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The anomalous achondrite Northwest Africa (NWA) 6704 has isotopic affinities with carbonaceous chondrites and shows geochemical evidence for a highly oxidized precursor and no sign of equilibration with a metallic melt. NWA 6704 and its paired samples are dominated by pyroxene with sodic plagioclase, Ni-bearing olivine, and rare chromite and awaruite (Ni_3Fe). The isotopic and geochemical link between the NWA 6704 pairing group and carbonaceous chondrites is consistent with significant hydration of the precursor materials. Both endogenic [1] and impact-melt [2] origins for NWA 6704 meteorites have been proposed. Here, we use infrared spectroscopy of pyroxene grains from NWA 6704 to show a distinct lack of hydration in the parent melt of NWA 6704, consistent with an origin as a superheated impact melt. The recent discovery of plausible parent asteroids for NWA 6704 [3] demonstrates that some apparently dry, “igneous” asteroids (including in the outer asteroid belt) may have originated as impact-melted material, possibly during catastrophic collisional disruptions.

[1] Warren et al., Geochimica et Cosmochimica Acta 107:135–154 2013 [2] Hibiya et al., Geochimica et Cosmochimica Acta 245(15) 597-627, 2018 [3] McGraw et al., in press, Astrophysical Journal 2020

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