RAMAN ANALYSIS OF DIAMOND IN ALMAHATA SITTA AND OTHER UREILITES.

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Introduction: The brecciated ureilite Almahata Sitta is the first meteorite to be collected after detection in space as an asteroid [1]. Ureilites are ultramafic, achondrite meteorites and are carbon-rich (up to 7 wt%) [2,3]. Carbon is present primarily as graphite and diamond. The origin of diamond in ureilites is still controversial. Two theories are favored: formation from graphite by impact shock [4], or formation by chemical vapor deposition (CVD) prior to accretion of the ureilite parent body [5]. This is the first study of diamond in Almahata Sitta. We present micro-Raman map images and single spectra for diamond in Almahata Sitta and compare it with new data for seven unbrecciated ureilites and two brecciated ureilites.

Methods: Raman images were collected using a WITec α-scanning near-field optical microscope with a 532nm YAG laser excitation source. Single Raman spectra were collected with a JASCO NRS-3100 confocal microRaman spectrometer with a 532nm excitation source.

Results: Raman spectra for Almahata Sitta diamond show a peak center range of 1318.5 – 1330.2 cm^{-1} and a full-width at half-maximum (FWHM) range of 6.6 – 17.4 cm^{-1}. Diamond in unbrecciated and brecciated ureilite samples has average peak center wavenumbers of 1332.0 – 1333.6 cm^{-1}, a narrower range than Almahata Sitta and closer to that of terrestrial kimberlite diamond. However, unbrecciated and brecciated ureilites have a larger range of FWHM than diamond in Almahata Sitta. Raman mapping of diamond in Almahata Sitta shows small-scale heterogeneity in peak center.

Discussion: The change in peak center wavenumber and FWHM when compared to terrestrial diamond indicates the formation style and history of diamond. The larger peak shift away from terrestrial kimberlite diamond observed in Almahata Sitta may indicate the presence of lonsdaleite. Alternatively, the lower peak shifts of diamond in unbrecciated and brecciated ureilites may be evidence of an annealing step either following the initial diamond-generating shock or as a consequence of heating during reconsolidation of the breccia. We examine the different theories for diamond formation in ureilites, such as CVD and shock origin from graphite, and explore explanations for the differences between Almahata Sitta and other ureilites.

Conclusions: Raman spectra of diamond in unbrecciated and brecciated ureilites are indistinguishable but diamond in Almahata Sitta is distinct from both unbrecciated and brecciated ureilites.

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References: [1] Jenniskens P. et al. 2009. *Nature* 458:485-488. [2] Mittlefehldt D. W. et al. 1998. *RiM* **36**, ch. 4. [3] Goodrich C. A. et al. 2004. *Chem der Erde* 64:283-327. [4] Lipschutz M. E. 1964. *Science* 143:1431-1434. [5] Fukunaga K. et al. 1987. *Nature* 328:141-143.