Roles of Parent Body Metamorphism vs. Terrestrial Weathring in CO chondrite NWA 10507

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Carbonaceous Ornans-like (CO) chondrites are all petrologic type 3, indicating that the components of COs preserve records of their formation in the solar nebula [1]; however, they also preserve a range of metamorphic conditions involving variations in temperature, fluid rock reaction and oxidation [1-3], similar in some respects to the oxidation of hydrated chondrites and samples recently returned from C-type asteroids [4,5]. Another setting for oxidation of chondrite finds is terrestrial weathering on the surface of the Earth [6].
In this project, we identify variably oxidized matrix domains in a primitive CO 3.0 chondrite, Northwest Africa 10507 (NWA 10507; see Fig. 1), and test whether the oxidation is due to: (1) incipient metamorphism on the CO parent body or (2) incipient weathering on Earth. NWA 10507 is considered to be CO 3.0, which indicates a pristine (very weakly metamorphosed) condition; however incipient metamorphism might have caused the difference of texture. On the other hand, NWA 10507 is a find meteorite from Northwest Africa, so it has undergone terrestrial weathering after falling to the Earth. To evaluate metamorphic grade and weathering effects in NWA 10507, we collected detailed back-scattered electron (BSE) and elemental images, element analyses, and Raman spectra from oxidized (BSE-bright) and reduced (BSE-dark) domains in NWA 10507 (Fig. 1). We compared NWA 10507 with similar analyses in Yamato-81020 (Y-81020, CO 3.0), Isna (CO 3.8).
The Raman spectra of D- and G-bands in matrix domains show that: (1) Isna was metamorphosed at relatively high-temperature conditions compared to other CO chondrites, consistent with results from [7]; (2) NWA 10507 and Y-81020 are both weakly metamorphosed, but NWA 10507 is more primitive (less metamorphosed) than Y-81020; (3) spectra from the BSE-bright and BSE-dark matrix domains overlap within uncertainties (Fig. 2). Small veins in the BSE-bright domains of NWA 10507 consist of Fe-oxide. The valence of Fe and possible hydration in the veins were not determined. Similar veins were not identified in Y-81020, which, according to the Raman parameters, was metamorphosed at higher temperatures than NWA 10507 on the CO parent body.
The Raman spectra and vein textures suggest that the BSE-bright domains of NWA 10507 result from incipient weathering on the Earth’s surface. The variable weathering preserved in NWA 10507 makes this meteorite an interesting sample for studies of terrestrial weathering. The extremely weak metamorphic condition makes NWA 10507 a promising sample for research requiring pristine records of rock formation in the solar nebula.
References: [1] McSween Jr., H.Y. (1977) *GCA* 41: 477-491.[2] Chizmadia L.J. et al. (2002) *MAPS* 37: 1781-1796. [3] Grossman J.N. and Brearley A.J. (2005) *MAPS* 40: 87-122. [4] Nakamura T. et al. (2023) *Science* 379: eabn8671 (14 pages). [5] Connolly H.C.Jr. et al. (2024) *LPSC* 55: 1281. [6] Velbel M.A. (2014) *MAPS* 49, 154-171. [7] Bonal L. et al. (2007) *GCA* 71: 1605-1623.

Keywords: Carbonaceous Chondrite, Raman Spectroscopy, Asteroid Metamorphism, Terrestrial Weathering

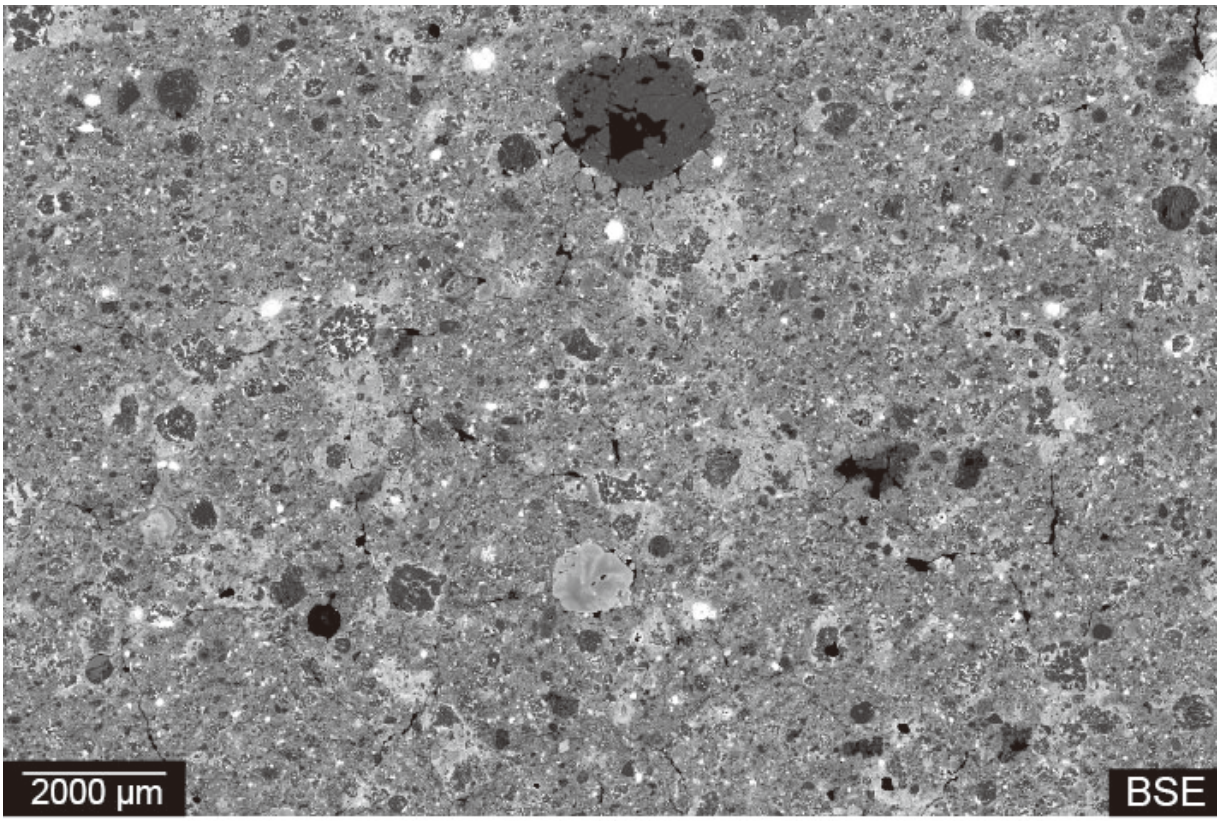

Figure 1. BSE map of NWA 10507. BSE-bright areas occur as patches surrounded by BSE-dark matrix.

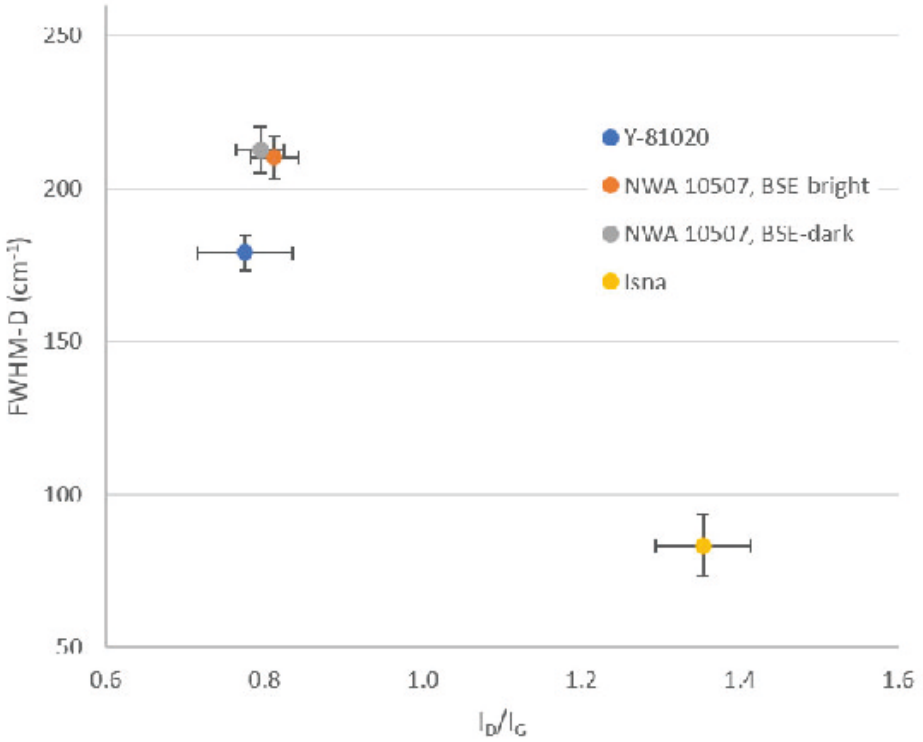

Figure 2. I_D/I_G vs. FWHM-D from all Raman analyses data. Y-81020 (blue) is average of 13 data, NWA 10507 BSE-bright (orange) is average of 7 data, NWA 10507 BSE-dark (gray) is average of 7 data, Isna (yellow) is average of 10 data.

