A FIB/TEM/NANOSIMS STUDY OF A WARK-LOVERING RIM ON AN ALLENDE CAI. L. P. Keller[1], A. W. Needham[2] and S. Messenger[1]. [1]Robert M. Walker Laboratory for Space Science, Code KR, ARES, NASA/JSC, Houston, TX 77058. [2]LPI, 3600 Bay Area Blvd., Houston, TX 77058. Lindsay.P.Keller@nasa.gov

Introduction: Ca- Al-rich inclusions (CAIs) are commonly surrounded by Wark-Lovering (WL) rims - thin (~50 μm) multilayered sequences - whose mineralogy is dominated by high temperature minerals similar to those that occur in the cores of CAIs [1]. The origins of these WL rims involved high temperature events in the early nebula such as condensation, flash-heating or reaction with a nebular reservoir, or combinations of these processes. These rims formed after CAI formation but prior to accretion into their parent bodies. We have undertaken a coordinated mineralogical and isotopic study of WL rims to determine the formation conditions of the individual layers and to constrain the isotopic reservoirs they interacted with during their history. We focus here on the spinel layer, the first-formed highest-temperature layer in the WL rim sequence.

Results and Discussion: We have performed mineralogical, chemical and isotopic analyses of an unusual ultrarefractory inclusion from the Allende CV3 chondrite (SHAL) consisting of an ~500 μm long single crystal of hibonite and co-existing coarse-grained perovskite. SHAL is partially surrounded by WL rim. We previously reported on the mineralogy, isotopic compositions and trace elements in SHAL [2-4].

The spinel layer in the WL rim is present only on the hibonite and terminates abruptly at the contact with the coarse perovskite. This simple observation shows that the spinel layer is not a condensate in this case (otherwise spinel would have condensed on the perovskite as well). The spinel layer appears to have formed by gas-phase corrosion of the hibonite by Mg-rich vapors such that the spinel layer grew at the expense of the hibonite. We also found that the spinel layer has the same ^{16}O-rich composition as the hibonite. The spinel layer is polycrystalline and individual crystals do not show a crystallographic relationship with the hibonite. An Al-diopside layer overlies the spinel layer, and is present on both the hibonite and perovskite. While the spinel is ^{16}O-rich, WL-rim perovskite and pyroxene are ^{16}O-poor. This isotopic heterogeneity likely reflects O isotopic equilibration of WL-rim perovskite and pyroxene with a planetary O isotopic reservoir after the WL rim formation. The hibonite is zoned and contains wt.% levels of Ti, Mg and Fe in contact with the Fe-bearing spinel ($Sp_{60}Hc_{40}$) in the WL rim. The Fe enrichment in spinel is likely related to the Na-Fe metasomatism that is ubiquitous in Allende.

Conclusions: The petrography and microstructure of the spinel layer in a WL rim sequence shows that it formed by gas phase reactions at high temperature in the nebula. The oxygen isotopic composition of the spinel indicates that this WL rim layer formed in the same (or similar) nebular gas reservoir as the host CAI.

References: [1] Wark D.A. & Lovering J.F. (1977) *LPS* 8, 95. [2] Keller, L. P. *et al.* (2012) *MAPS* #5313. [3] Needham, A. W. et al. (2013) *MAPS* #5307. [4] Mane, P. *et al*. (2013) *MAPS*, #5268.