Willcox Playa 010: a highly reduced lodranite. J. A. Utas[1], A. E. Rubin[1], and K. Ziegler[2] [1]Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90095-1567, USA (jutas@ucla.edu). [2]Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131, USA

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Introduction: Acapulcoites and lodranites are remnants of the same chondritic parent body that underwent partial melting and compositional evolution in a reducing environment. Some acapulcoites retain relict chondrules, and all exhibit grossly chondritic compositions with Mg-normalized refractory lithophile abundances comparable to those observed in CI chondrites [1]. Most acapulcoites and lodranites have been thoroughly recrystallized, but have experienced minor loss or enrichment of volatile phases. The extent of silicate recrystallization generally correlates with depletion of FeS and plagioclase, the two abundant phases with lower melting temperatures than the primarily olivine and pyroxene restite.

The nature of the metamorphism of the acapulcoite/lodranite parent body is currently unclear; subsequent annealing has erased textural traces of the recrystallizing event, and the range of samples from the parent body is limited to the ~60 distinct acapulcoites and lodranites currently in collections. The metamorphism has been attributed to a few possible causes; McCoy et al. [2] ascribe the melting to solid-state recrystallization via internal heat sources, whereas Rubin [1] favors a model in which post-shock annealing has erased traces of impact-induced heating and partial melting.

Samples and Technique: A 22.3-g stone was found while systematically hunting for meteorites on Willcox Playa, in southern Arizona (Fig. 1). The find consisted of a single, completely fusion-crusted, shield-shaped stone approximately 3.5 × 3 × 1 cm. The fusion crust was locally abraded, revealing a crystalline interior dominated by grains <1 mm in diameter. A 1-2-mm-thick rim of fusion crust up to 1cm wide rimmed one face of the stone. Analysis was completed using a JEOL electron microprobe with additional observations made microscopically with a thin section in plane and cross-polarized light. The oxygen isotope composition of a few aliquots of this stone are presently being analysed by laser-assisted fluorination techniques at UNM.

Figure 1. The 22.3 gram stone shortly after discovery.

Results: The stone is comprised of 0.5-1.2 mm (avg. ~0.7 mm) orthopyroxene, olivine, and Ca-rich clinopyroxene grains (Fs 5.7±0.5 Wo 21.9±0.6; (n=6)). Ni-poor kamacite (5%) and terrestrial oxides are also present (~25% total volume), in addition to troilite (4%) and Ni-bearing schreibersite (1 - 2%). No plagioclase was observed. Pyroxene grains exhibit abundant crystallographically controlled exsolved Ni-poor metallic Fe (Fig. 2). The stone's composition and lack of plagioclase indicate that it is a highly reduced member of the acapuolcoite/lodranite clan. Its coarse texture and the extent of reduction indicate that it is a lodranite. Plagioclase, Cr-diopside, and other Cr-bearing minerals are characteristic of winonaites, but are very rare to absent in this sample. The oxygen isotopic composition of this rock will aid classification, as different, yet chemically similar, meteorite groups can be discerned on the basis of oxygen isotope compositions [3].

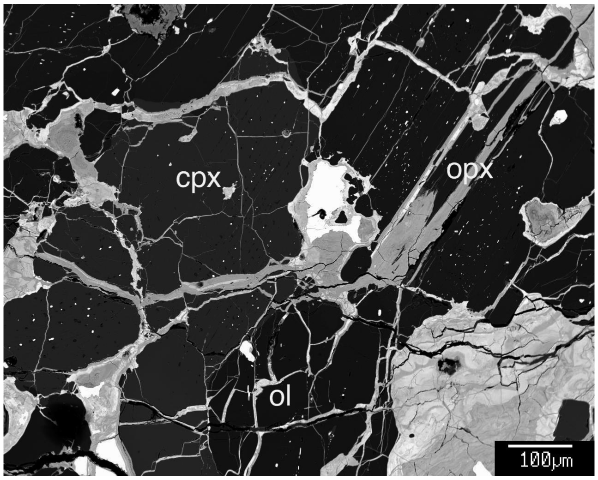

Figure 2. BSE image showing exsolved iron in orthopyroxene. Ca-rich clinopyroxene (cpx), orthopyroxene (opx), and olivine (ol) are visible. Veins are filled with metallic iron, oxides, and troilite.

Discussion: Oxygen-isotope data will be reported at the conference**.** Should the data confirm the association of Willcox Playa 010 with the acapulcoite/lodranite family, this meteorite will represent the most reduced lodranite yet found (Fa 2.8±0.2, Fs 4.0±0.2). Compositionally, it most closely resembles LEW 88280 (Fa 13, Fs 11.9) and MAC 88177 (Fa 13.7, Fs 12.8) [4,5]. All three stones lack plagioclase and do not display a corresponding depletion of troilite [4,5]. While an estimate of the oxygen fugacity of acapulcoite parent body reduction has been put forth, these data suggest that the actual oxygen fugacity may have shown significant localized variation [6].

LEW 88280, MAC 88177, and Willcox Playa 010 are probably not simple plagioclase-depleted partial melts. Several previously studied lodranites (e.g., LEW 86220 and GRA 95209) exhibit particularly evolved compositions or textures. Examination of the REEs present in the silicate phases of LEW 86220 suggests that this meteorite was a fairly typical acapulcoite intruded by lodranite-sourced felsic melt [2,7]. GRA 95209 is a complex heterogeneous meteorite with some regions comprised of solid Fe-Ni and some regions with nearly no metallic Fe. It, too, contains regions that appear to be enriched in melt more felsic than most lodranites [8]. LEW 88280 and MAC 88177 exhibit corresponding pyroxene zoning and REE abundances suggesting that they have lost significant melt fractions in a reducing environment, including ~15-20% of silicate minerals [7,4]. Reverse zoning of olivine was noted in Lodran, but most acapulcoites/lodranites have not been reported to exhibit such REE zoning [9].

The discovery of lodranites that have little plagioclase, but still retain some troilite, is not surprising. Chondritic plagioclase is primarily albitic in nature, and should have a melting temperature of ~1110°C. Troilite melts at ~1190°C. All observed variation between acapulcoites and lodranites has been attributed to a total temperature range of <300°C near the Fe-Ni-S eutectic [1,2,4]. However, the (lack of) relationship between the degree of reduction of a given acapulcoite/lodranite and its bulk composition is problematic. Willcox Playa 010 exhibits a unique feature amongst acapulcoites and lodranites; crystallographically controlled, exsolved Ni-poor metallic Fe is abundant within most pyroxenes in the meteorite. The only metallic phase with >1% Ni is iron phosphide. Nearly all chondritic metal has been removed and replaced with iron liberated by reduction and these primary reduction features are still clearly visible.

Conclusion: Willcox Playa 010 may help explicate the thermal history of the acapulcoite/lodranite parent body. Given the stone's preservation of features that formed in highly reducing conditions, it likely retains additional REE zoning formed in the reducing event(s) that contributed to the metamorphism of the acapulcoite/lodranite parent body. A comparison of Willcox Playa 010 with other odd lodranites may shed some light on early planetary formation processes.

References: [1] Rubin, A.E. (2007) GCA 71, 2383-2401. [2] McCoy, T.J. et al. (1996) GCA 60, 2681-2708. [3] Clayton, R.N. & Mayeda, T.K. (1996) GCA 60, 1999-2017. [4] Miyamoto, M. and Takeda, H. (1994) JGR 99, 5569-5677. [5] Yugami, K. et al. (1998) AMR 11, 49-70. [6] Benedix, G.K. & Lauretta, D.S. (2006) LPSC XXXVII Abstract 2129. [7] Floss, C. (2000) MAPS 35, 1073-1085. [8] McCoy, T.J. et al (2006) GCA 70, 516-531. [9] Bild, R.W. & Wasson, J.T. (1976) MM 40, 721-735.