Pallasites: olivine-metal textures, phosphorane olivine, and origin

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Four questions:
1. Why do some pallasites have rounded olivines?
2. Why is phosphorane olivine only found in five main-group pallasites?
3. Why do four main group pallasites with rounded olivines contain anomalously Fe-rich olivine?
4. Where did main group and Eagle Station group pallasites form?

1. Origin of rounded olivine
Did cm-sized rounded olivines form before angular olivines [9], or were olivines rounded after fragmentation of olivine [2,3,7]? Constraints:
- Uniform size distribution of rounded olivines in Fig. 1c is unlike that of angular olivine pallasites which may contain dune fragments several cm in width (Fig. 1a).
- Angular olivine pallasites may contain pieces of rounded olivine texture (Fig. 1b).
- Pavlovodar (Pa) has rounded olivines and plots near the initial melt composition, showing that rounding preceded metal crystallization. Marjalahti (Ma), Huckitta (Hu) and Seymchan (Sc) have angular olivines and formed after 30-50% crystallization. Br: Brenham, Kr: Krasnoyarsk, Ra: Rawlinna, Sp: Springwater, TM: Thet Mountains. Adapted from [2].

Conclusion: Brenham-like texture with cm-sized rounded olivines is the primary texture.

2. P-rich olivine
Tiny grains of P-rich olivine and Ca and Ca-Fe-Mg phosphates formed from trapped silicate melt that was enriched in P from molten metal via redox reactions [12]. Where did main group and Eagle Station group pallasites form?

3. Origin of the four Fe-rich Mg pallasites

Fig. 5. Cartoon showing how dunite mantle (zone 1) and Brenham-like olivine (zone 3) may form at the core-mantle boundary. Zone 2 is a metal-poor Brenham-like region. Fig. 1a-c show olivines from zones 1-3, respectively. Adapted from Wood [8].

Conclusions
1. cm-sized rounded olivines formed when equant olivine crystals were immersed in molten metal at the core-mantle boundary. Angular olivine fragments formed later and were micro-rounded in solid Fe-Ni.
2. Phosphorane olivine in Mg pallasites from trapped pockets of P-rich silicate melt [12,14]. It occurs in pallasites with rounded olivines and low-Ir metal (0.1 μg/g) as those contained trapped silicate melt that equilibrated with molten metal in P-rich, Ir-poor metal.
3. Fe-rich olivine formed in four Mg pallasites when Fe was oxidized to replace Mg from olivine that combined with P and O in molten metal to form farringtonite, MgPO_4.
4. Eagle Station group pallasites have mass-independent isotopic compositions like those in carbonaceous chondrites and formed beyond Jupiter. Main-group pallasites formed in the asteroid belt. Both formed from core-mantle boundary materials.

References: