**REHEATING AND COOLING OF MESOSIDERITES.** N. Sugiura[1] and M. Kimura[2], [1]Department of Earth and Planetary Science, Univ. of Tokyo, Japan, [2]Faculty of Science, Ibaraki University, Japan.

**Introduction:** Mesosiderites were reheated after the mixing of silicates and metal. According to the observation of the most primitive mesosiderite Northwest Africa 1878 [1], the metal was solid at the time of mixing and was not the heat source for reheating. The cooling after the reheating at high temperatures as recorded by silicates was rapid suggesting that they resided in the regolith layer near the surface of the parent body [2]. Schreibersite morphologies and compositions were established at intermediate temperatures (from 600 C to 400 C or lower). Differences in the cooling rates in this temperature range were discerned among mesosiderites based on observations of schreibersite [3]. Here we examine the relationship between cooling rates at high temperatures and intermediate temperatures.

**Samples:** Mesosiderites included in this study are Northwest Africa 2924, Estherville (A3/4), Crab Orchard (A1), NWA 1878 (B0), Allan Hills 77219 (B1), Northwest Africa 1242 (A2) and Asuka 882023. NWA 2924 contains areas with igneous texture (acicular plagioclase). Also, the texture of silicates at metal-silicate boundary (Fig.1) suggests that the peak temperature was above the solidi of silicates and metal. Therefore, its metamorphic degree is considered to be similar to that of Estherville. The presence of a large zircon grain (80 μm x 40 μm) in Asuka 882023 suggests that it experienced considerable metamorphic reheating. We suggest A2 classification for Asuka 882023.

**Cooling rate at high temperatures:** Pyroxene compositional gradients, phosphide/phosphate abundance ratios and pyroxene lamellae widths are possible indicators of cooling rates at high temperatures.

*Pyroxene compositional gradient.* Pyroxenes around olivine show compositional gradients. They are more magnesian at the interface with the olivine. In addition to cooling rates, the gradients are affected by peak reheating temperatures, olivine sizes and redox conditions. Slow cooling is suggested for Asuka 882023 whose pyroxene around a large olivine shows a negligible compositional gradient. Relatively fast cooling is suggested for Crab Orchard, NWA 2924 and Estherville whose pyroxenes show steep compositional gradients, although the gradients in the latter two mesosiderites may be affected by reducing conditions. Relatively slow cooling is suggested for the remaining three mesosiderites. In the case of NWA 1878, a cooling rate of ~0.01 C/year is suggested based on diffusion simulations assuming that the interface composition was fixed during cooling.

*Phosphide/phosphate abundance ratios*. Phosphates are produced by oxidation of phosphorous in the metal [4]. The phosphate forming reaction is likely to have ended by ~800 C, depending on the cooling rate. At the end of this reaction, the remaining P in the mesosiderite metal of this study is less than ~0.2 wt. %. At this concentration, schreibersite formation starts at 600 C [5]. Phosphide/phosphate abundance ratios were affected by cooling rates, metal grain sizes and metal abundances. The former two factors are related to the closure of the phosphate formation reaction, whereas the last factor is related to the equilibrium value. NWA 2924 and Estherville show high phosphide/phosphate ratios, suggesting rapid cooling down to ~800 C, although the metal grain sizes may have significantly affected the ratios. Asuka 882023 shows the lowest ratio, indicating very slow cooling.

*Pyroxene lamellae width*. Pyroxene lamellae in mesosiderites are generally thin compared with those in eucrites. Pyroxenes in NWA 2924, NWA 1878 and ALH 77219 show fine lamellae (less than 1 micrometer thick). The pyroxene exsolution temperature depends strongly on the Ca and Fe contents. The Ca contents are controlled by the phosphate formation reaction which in turn depends on metal abundances, metal grain sizes and cooling rates. The lamellae widths depend on the exsolution temperatures and the subsequent cooling rates. Therefore, the lamellae thickness depends on many factors and is not a good indicator of cooling rates of mesosiderites.

**Relationship between high and intermediate temperature cooling rates:** Both schreibersite morphologies and compositions suggest that NWA 2924 and Estherville cooled rapidly at intermediate temperatures whereas the remaining five mesosiderites cooled more slowly [3]. Putting this and cooling rates at high temperatures together, it appears that NWA 2924 and Estherville cooled rapidly at high and intermediate temperature ranges. Also, Asuka 882023 appears to have cooled slowly at high and intermediate temperature ranges. Therefore, we conclude that various mesosiderites remained in the regolith layer down to ~400 C or lower. Since both NWA 2924 and Estherville experienced high peak temperatures, this may suggest that the heat source was located near the surface of the parent body.

The remaining four mesosiderites show intermediate phosphide/phosphate ratios. Their schreibersite features are similar to those in Asuka 882023. The relationship between the cooling rates at high and intermediate temperatures is not clear for these mesosiderites. In particular, NWA 1878 which is the most primitive mesosiderite appears to have cooled somewhat faster than Asuka 882023. This cannot be explained easily by a simple model where a heat source was located near the surface.

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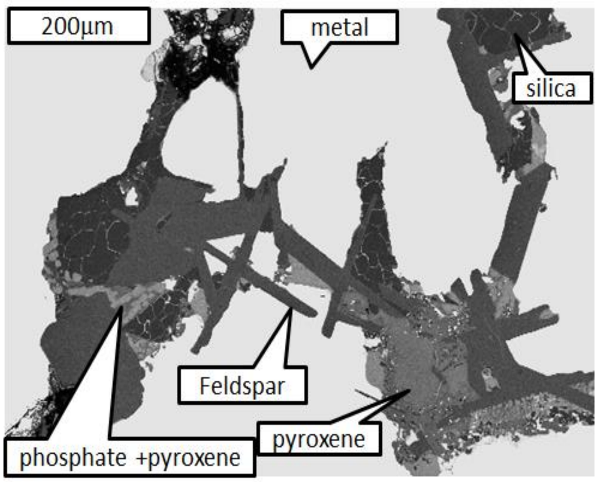


Fig.1 Backscattered electron image of a metal-rich area of NWA 2924. Thin feldspar grains protruding into metal suggest their the rapid growth at an above-solidi temperature.