PETROGENESIS OF MAFIC LITHOLOGIES IN MESOSIDERITES: David W. Mittlefehldt, SN4, NASA-Johnson Space Center, Houston, TX 77058, (NRC Associate).

Early petrologic work on mesosiderites showed that they contain mafic magmatic clasts similar to eucrites and cumulate eucrites (1,2). Later, trace element and petrologic work on a limited number of basaltic and gabbroic clasts pointed out some unusual features of mesosiderite mafic lithologies (3,4). A more extensive petrologic survey (5-7) established several unique properties of mesosiderites as compared to basaltic and cumulate eucrites viz. 1. greater abundance of tridymite and phosphate, 2. common occurrence of magmatic augite, and 3. generally more Mg-rich pyroxene compositions in the former. Here, I will integrate new and previous (3,4) trace element and petrologic data to constrain the petrogenesis of mesosiderite mafic lithologies. Samples studied include separated clasts and clasts in thin sections from the mesosiderites Clover Springs, Crab Orchard, Mount Padbury, Patwar, Um Hadid and Vaca Muerta. Comparison studies were performed on material from the eucrites and howardites Bununu, EETA83376, Jodzie, Moore County, Nobleborough, Pavlovka and Petersburg.

Petrology Nehru et al. (5) showed that mesosiderite basalt pyroxenes were more Mg-rich than common eucrites. Pyroxenes from basaltic clasts in polymict eucrites extend into the Mg-rich range of mesosiderite basalts, but this is a feature of igneous fractionation from initial Mg-rich pyroxenes to late, Fe-rich pyroxenes (8). In contrast, where a significant range of pyroxene compositions exists in mesosiderite basalts, the initial pyroxenes are Fe-rich and the late, mesostasis grains are Mg-rich (9). Pyroxene compositions in mesosiderite mafic clasts show a general positive correlation between molar Fe/Mn and Fe/Mg, while the achondritic meteorite clasts show a near vertical trend (Fig. 1). The trend in the latter is explicable as a normal igneous fractionation trend in which almost no fractionation occurs in the Fe/Mn ratio. In contrast, the mesosiderite mafic trend is controlled by FeO reduction in the magma resulting in increasingly Mg-rich pyroxenes with increasing FeO reduction.

Some mesosiderite gabbros contain pyroxenes poikilitically including small, rounded grains of plagioclase; a feature not observed in Moore County or gabbroic clasts in achondrites. In Moore County, plagioclase included in pyroxene is generally, but not universally, euhedral-subhedral and concentrated near grain margins. I interpret the plagioclase inclusions as representing xenocrystic material that was initially present in the magma. This is supported by the occurrence of plagioclase xenocrysts in some basalt clasts, and the trace element evidence below. Preliminary analyses of the plagioclase inclusions in two gabbros show that they are more anorthitic than the descrete plagioclase grain cores. This is compatible with either a xenocrystic or a magmatic origin for the plagioclase inclusions.

Composition A common feature of many mesosiderite basalts is a positive Eu anomaly and slight LREE depletions (4, 10). The gabbros generally are depleted in incompatible elements and show extreme LREE depletions when compared with cumulate eucrites (Fig. 2) (4, 10, 11). Modelling of the REE in gabbros shows that some of the gabbros were derived from melts exhibiting positive Eu anomalies and/or LREE depletions (4,11). Previous modelling of some mesosiderite gabbros has suggested that they were most likely formed from remelted cumulates (4). Previous modelling of the genesis of the basalts suggested that they may have been formed from residual sources (4), but this is now viewed as incorrect (below).

MESOSIDERITE MAFIC LITHOLOGIES
David W. Mittlefehldt

Petrogenesis The petrologic and trace element evidence indicates that the mesosiderite mafic lithologies were formed as a result of remelting of plagioclase-rich source regions (plagioclase xenocrysts, positive Eu anomalies). The pyroxene compositions clearly show evidence for FeO reduction processes having occurred in the magma. On the mesosiderite parent body, FeO reduction is the result of mixing of the metallic and silicate fractions (12) and is a regolith process. This indicates that the remelting occurred as a result of impact. The trace element and petrologic evidence shows that the melted target rock was probably a mixed basaltic-gabbroic source region. Preliminary chronologic data suggests that this impact melting occurred very early in the history of the parent body. The required slow cooling to produce the mesosiderite gabbros may have been provided by a blanket of ejected debris from other nearby cratering events during an intense early bombardment.

(1) McCall (1966) Min Mag 35, 1029. (2) Powell (1971) GCA 35, 5. (3) Mittlefehldt (1978) Ph.D. thesis, UCLA. (4) Mittlefehldt (1979) GCA 43, 1917. (5) Nehru et al. (1980a) LPS XI, 803. (6) Nehru et al. (1980b) Meteoritics 15, 337. (7) Delaney et al. (1982) LPS XIII, 152. (8) Takeda et al. (1983) PLPSC 14, B245. (9) Mittlefehldt et al. (1986a) LPS XVII, 553. (10) Rubin and Jerde (1987) EPSL, submitted. (11) Mittlefehldt et al. (1986b) Meteoritics, in press. (12) Mittlefehldt et al. (1979) GCA 43, 673.

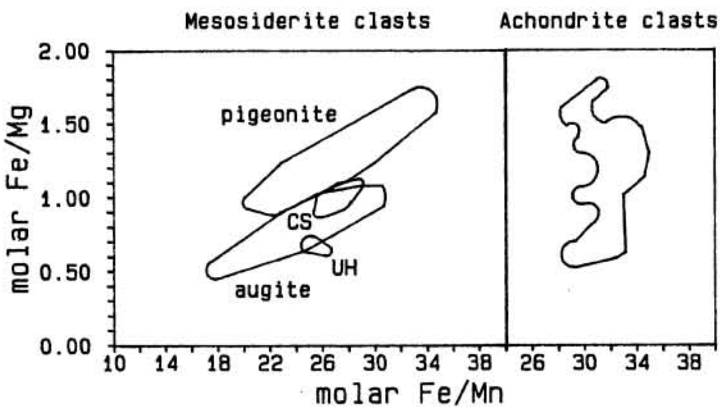

Fig. 1. Pyroxene analyses of mafic clasts in eucrites and howardites compared with mesosiderite clasts. Pigeonites in gabbro clasts from Clover Springs and Um Hadid are shown separatly. All other basalt and gabbro clasts occupy the general fields.

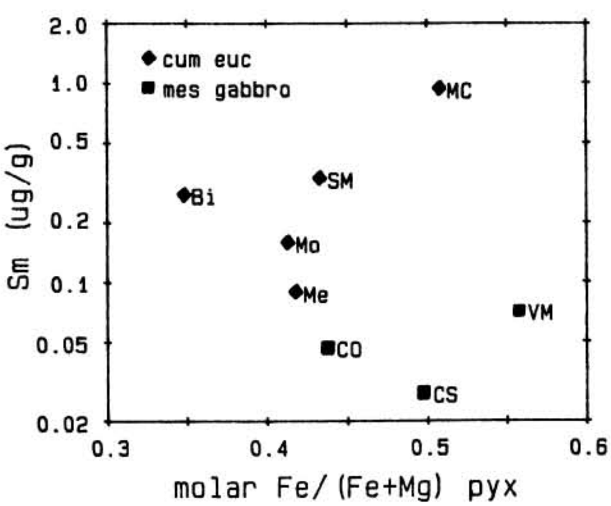

Fig. 2. Bulk pyroxene composition vs. Sm for cumulate samples show that mesosiderite clasts (Crab Orchard, Clover Springs, Vaca Muerta) are depleted in incompatibles relative to cumulate eucrites (Binda, Medanitos, Moama, Moore County, Serra de Mage).