CATCHING CONSTRAINTS ON THE PARENT BODY GENESIS OF MESOSIDERITES AND A POSSIBLE LINK TO HED (HOWARDITE-EUCRITE-DIOGENITE) METEORITES – A NEW HOPE?

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Introduction: Mesosiderites (MES) are a group of enigmatic stony-iron meteorites exhibiting fragmental matrix breccias and irregular textures; e.g. [1,2]. Many specimens contain roughly equal volumes metal (Fe-Ni) and silicates often intimately mixed together (Fig.1). The silicates mostly consist of basaltic, gabbroic, and pyroxenitic components, and appear similar, but, however, not identical to eucrites and howardites; e.g. [3-8]. Several studies have been published to reveal the processes leading to the formation of mesosiderites and attempt to classify them [1,2,9-15].

Because the silicate inclusions in MES are often strongly metamorphosed after formation, it is difficult to assess the origin of the silicates and implications for the differentiation process of their parent body [16,17]. Overall, MES silicates indicate their origin and residence at the surface of a differentiated body [18], but the slow cooling rate of the metal points to an origin in the deep interior [e.g. 19]. Following [19], there are two main explanations for the silicate/metal mixing. The first posits that mixing of near-surface silicates with the interior core-metal on a single parent body, by an event such as a catastrophic breakup (e.g. [18]). The second, more widely-invoked model describes large impacts and re-assembly of multiple precursor bodies - whether of differentiated or primitive origin - as the main cause for silicate/metal-mixing (e.g. [1,2,8,9,11,15]). A mixing event must have been followed by surface brecciation, deep material burial along with slow cooling, and later remelting and/or metamorphosis.

Many published metallographic cooling rates on mesosiderites (e.g. [17,20,21,22]), of ~0.05-0.2 K/Ma, are slower than might be expected given the rapid nature of impact or breakup events. [23] discuss that the relatively slow metallographic cooling rates of mesosiderites are, however, in agreement with slow cooling of a large parent body to the closure temperature of Ar ~4 Ga ago, which is the age of many silicate inclusions. This raises the question, do the Ar-Ar ages give a closure temperature of a large parent body or could they be the result of later impacts? Hence, an important and still unresolved question and the main goal of this research is the parentage of mesosiderites.

Because MES contain a diverse mineralogy many studies on the formation model of MES focused on Type A1 meteorite *Vaca Muerta* [14,15,24], since large silicate inclusions are available and it is one of the least recrystallized MES. In addition, many attempts focused either on silicates or metals, but not both together. Concerning noble gases, the compilation of [25] and references therein show He to Ar data on 23 mesosiderites, but, it is lacking on Kr and Xe data. [26] report 37 MES in 2014 which makes new measurements possible and necessary. We think a more integrated approach is necessary to reveal the history of the mesosiderites.

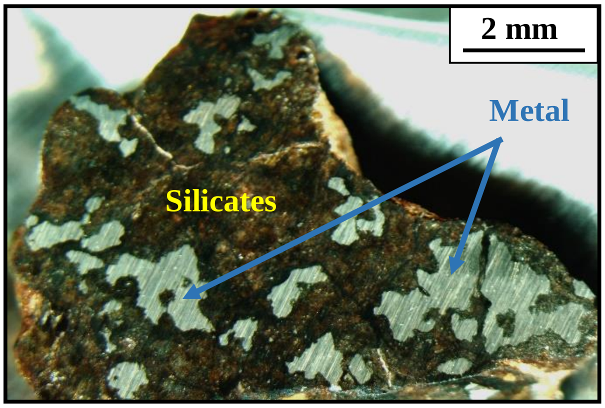

Fig.1. The Type A1 MES *Toufassour*. Well visible are the abundant silicate and metal phases which seem to have an interstitial character.

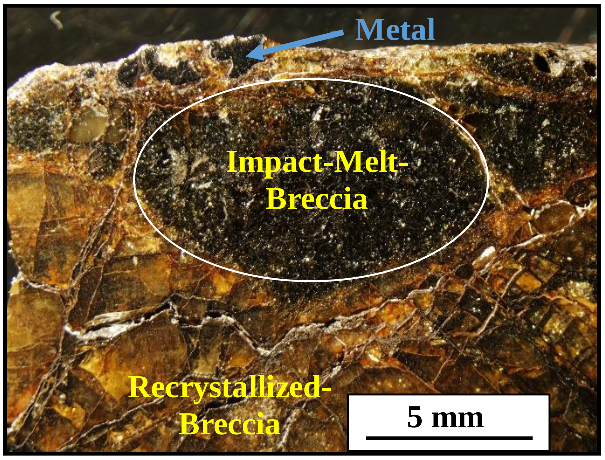

Fig.2: The highly metamorphosed and recrystallized brecciated silicates of the *Bondoc* mesosiderite (Type B4). Metal inclusions are observable at the top.

Experimental: We are attempting to recognize and choose the least recrystallized clasts in mesosiderites (Type A1, A2, B1, B2) to perform studies on the differences between silicate and metal chronology, as well as the noble-gas inventory of these clasts as clues to their origin. We will search MES samples for clasts that consists of orthopyroxene and plagioclase that appear to be co-genetic, or at least related to, metal blebs. We will characterize the composition and petrography of these clasts using stereo-microscopy, SEM and electron microprobe along with calculating metallographic cooling rates. We will analyze the noble-gas complement (He-Xe) of the silicate inclusions and assess Ar-Ar and cosmic-ray exposure ages using the MSFC state-of-the-art Noblesse (Nu Instruments, UK) mass spectrometer. If material allows, we will then measure Sm, Yb and Eu in the clasts to compare with HEDs. At this time *Toufassour* / Type A1 (Fig.1), *Northwest Africa 1242* / Type A2 and the highly weathered *Northwest Africa 8561* / Type A1 are at hand. We also picked *Bondoc*, a highly recrystallized Type B3/4 mesosiderite, to be able to compare our findings (Fig. 2).

We first will use the petrology and composition of the clasts to understand their silicate mineralogy. Their noble gas inventory will help us understand both, their origin and burial history. We expect most of these will show an achondritic signature, but if we find a more chondritic noble-gas signature, we may infer that an impacting body was responsible for contributing more primitive material. Deficiencies in primordial abundances might link burial depth to equilibration temperatures, especially for Type A1 to A2 MES [9]. Post-accretion metamorphosis, recrystallization and terrestrial weathering (see Fig. 3) should be observable as depletions in the noble gases, particularly He and Ne. In clasts that spent a long time at or near the surface, large cosmogenic, i.e. spallation, contributions should be detectable for Ne, Ar and Xe, and we will determine their cosmogenic exposure ages. If Xe derived from radiogenic decay is detected, this would indicate the primitiveness of the material. In each clast, we will measure the metallographic cooling rates and compare them to Ar-Ar ages; if these agree within single clasts, we can infer closure temperatures connected to the burial depth.

Our results may also shed light on processes comparing MES with groups of differentiated meteorites similar in mineralogy, texture and possible formation history; i.e. HEDs, anomalous and silicate bearing iron meteorites e.g. [4,7]. Generally, Mesosiderites contain low primordial trapped contributions in contrast to most howardites, which often show high trapped and solar contributions [27]. MES have numerous gabbroid melt clasts with anomalous rare-earth-element (REE) - especially positive Eu - values [4,15]. HEDs do not show the same. However, even if the HEDs and MES were not formed in the same parent body, the processes that created them may reflect similar processes on differentiated bodies.

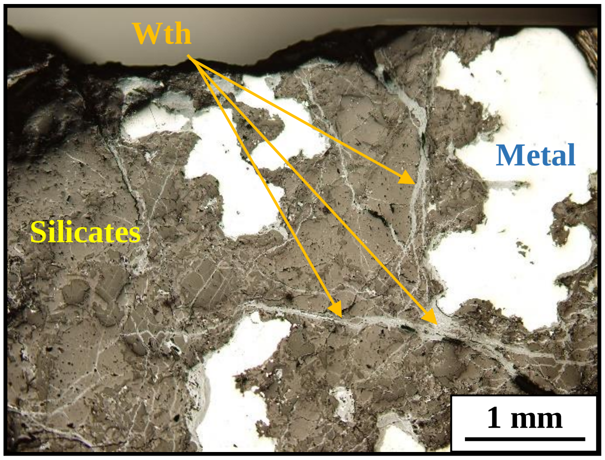

Fig.3. Reflected-light image of a part of the Type A1 MES *Toufassour* in Fig. 1. Observable are many small to large metal and brecciated silicate inclusions. The area shows abundant weathering veins (Wth) and metal overgrowths.

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