**Rb-Sr AND Sm-Nd AGES OF PLAGIOCLASE-DIOPSIDE-RICH MATERIAL IN CADDO COUNTY IAB IRON METEORITE.**

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**Introduction:** The determination of the chronology of iron meteorites is critical to decipher the timing of accretion, melting, segregation and the subsequent cooling history of their parent bodies. Group IAB, IIICD and IIE from a total of 13 groups of classified iron meteorites are believed to have not undergone extensive melting and separation from silicates. These three groups of iron meteorites exhibit a unique characteristic in the presence of abundant silicate inclusions. This characteristic allows the indirect dating of iron meteorites using several chronometers that cannot be applied to the Fe-Ni phases. Although intensive studies on the silicate inclusions of iron meteorites have been pursued for over three decades [1-3], the detailed formation and evolution history of groups IAB, IIICD and IIE still are not well known. Takeda et al [4] reported a $^{39}$Ar-$^{40}$Ar age of 4.520 ± 0.005 Ga for plagioclase-diopside-rich material in the Caddo County IAB iron meteorite. They proposed that segregation of metal and silicate and subsequent cooling to relatively low temperatures occurred early in the IAB parent body history. Stewart et al [5] reported a well defined $^{147}$Sm-$^{143}$Nd age of 4.53 ± 0.02 Ga and suggested a model of parent body formation: Incorporation of silicate material into the Fe-Ni phase at depths > 2 km and earlier within the first ~30 Ma of the solar system history. Another model, that of catastrophic impact-induced mixing, was proposed by Benedix et al. [6]. We have investigated the chronology of plagioclase-diopside-rich material in Caddo County by simultaneously using the $^{87}$Rb-$^{86}$Sr, $^{147}$Sm-$^{143}$Nd and $^{146}$Sm-$^{142}$Nd chronometers. This study aims at providing additional evidence on the timing of the formation of IAB iron meteorites.

**Sample description:** The Caddo County silicate inclusions were described Palme et al. [8], and the mineralogy, petrology and chemical compositions of the Caddo County plagioclase-diopside-rich (andesitic) material have been investigated thoroughly by Takeda et al. [4,7]. Sample 3Ba, a coarse-grained (up to 3 mm) material rich in plagioclase and diopside, was provided by the Planetary Materials Database Collection of the University of Tokyo for this study. The coarse-grained andesitic material is a region with transitional margins located mainly at silicate-metal boundaries with the surrounding ultramafic silicates. The mineralogy and chemical compositions of plagioclase-diopside-rich material and winoanite-like silicate inclusions in Caddo County are quite heterogeneous, shown by the comparison of sample 3Ba with other plagioclase-diopside-rich material in different parts of the Caddo County slab [4], and those reported by Palme et al. [8]. About 120 mg of sample 3Ba was gently crushed in a stainless steel mortar and pestle. To remove the staining in sample 3Ba, 75-150 µm fractions were washed in an ultrasonic bath in 2N HCl for 20 minutes. Mineral separates of plagioclase (PL), diopside (DIO) and impure diopside (DIO-IM) were prepared using a magnetic separator followed by handpicking.

**Results and discussion:** The Rb-Sr data are plotted in an isochron diagram in Fig. 1. The mineral separates and the whole rock (WR) of 3Ba reveal a significant $^{87}$Sr enrichment increasing from PL, to WR to DIO. The Rb-Sr isotopic data well-define a linear array, but they vary only within a small range, resulting in a relatively imprecise Rb-Sr age of 4.57 ± 0.23 Ga. This is the first reported Rb-Sr age from an internal isochron for a single inclusion. It is consistent with previous Rb-Sr ages of 4.66 Ga for El Taco and Toluca, and 4.56 Ga for Four Corners, derived from different inclusions within single IAB irons [3,9], as well as with the Rb-Sr age of 4.51 Ga derived from a group of five IAB irons [9] (recalculated for $\lambda=0.01402$ Ga$^{-1}$). The Rb-Sr age was further refined by calculating model ages for individual mineral separates by assuming a solar system initial $^{87}$Sr/$^{86}$Sr ratio. The model ages were calculated using the initial $^{87}$Sr/$^{86}$Sr ratios of the angrite LEW 86010 [10], eucrite A881394 [11], ordinary and cumulate eucrites [12], as well as BABI [13]. The model ages thus obtained lie between 4.55 to 4.59 Ga, indistinguishable from the canonical age of the solar system. In contrast to the Rb-Sr internal isochron age, our initial $^{87}$Sr/$^{86}$Sr ratio of 0.69900 ± 0.00039 is determined with good precision and is essentially identical to those obtained from the five IAB irons [9], and also with the results for angrites and eucrites [10,11].
material reported by Takeda et al. [4]. The initial \(^{146}\text{Sm}/^{144}\text{Nd}\) obtained is 0.505996 ± 0.000049 corresponding to \(\varepsilon_{\text{Nd}}^{142}(4.50 \text{ Ga}) = 0.47 ± 0.97 (2\sigma)\) relative to the CHUR value [14]. This indicates chondritic relative abundances of REE in the source material melted to form this plagioclase-diopside-rich material.

The \(^{146}\text{Sm}-^{142}\text{Nd}\) data are shown in Fig. 3. An initial \(^{146}\text{Sm}/^{144}\text{Sm}\) of 0.0094 ± 0.0040, with an initial \(^{142}\text{Nd}/^{144}\text{Nd}\) corresponding to \(\varepsilon_{\text{Nd}}^{142} = -2.3 ± 1.2\) is defined by the mineral separates and whole rock. This result is identical within uncertainties with \(^{146}\text{Sm}/^{144}\text{Sm}\) = 0.0086 ± 0.0021 and \(\varepsilon_{\text{Nd}}^{142} = -2.4\) (recalculated for \(^{142}\text{Nd}/^{144}\text{Nd}_{\text{CHUR}} = 1.138260\)) for the Caddo County silicate inclusion analysed by Stewart et al. [5], and \(\varepsilon_{\text{Nd}}^{142} = -2.5 ± 0.4\) for angrite LEW86010 reported by Nyquist et al. [10]. The initial \(^{146}\text{Sm}/^{144}\text{Sm}\) obtained here corresponds to a formation interval of -32 ± 50 Ma relative to the value of 0.0076 ± 0.0009 for LEW86010 [10]. This formation interval coupled with the \(^{147}\text{Sm}-^{143}\text{Nd}\) age of 4.53 ± 0.04 Ga for LEW86010 [10] suggests an “absolute” crystallization age of ~4.56 Ga for Caddo County plagioclase-diopside-rich material, which is consistent with our Rb-Sr age of ~4.57 Ga, as obtained both from the internal isochron (Fig. 1), and the ~4.55-4.59 Ga model ages. The apparently younger Ar-Ar and conventional \(^{147}\text{Sm}-^{143}\text{Nd}\) ages may represent a later reheating event, or delayed closure of the isotopic systems, particularly for plagioclase.

The Rb-Sr and Sm-Nd results suggest that the parent body of the Caddo County iron meteorite experienced partial melting and incomplete differentiation within the first ~60 Ma of the canonical age of solar system. Caddo County plagioclase-diopside-rich materials thus are products of very early differentiation of small planetesimals that preserve the signature of the early stage of the planetary differentiation.