TUPELO, A NEW EL6 ENSTATITE CHONDRITE. D. R. Dunlap[1] (ddunlap3@utk.edu), M. L. Pewitt[1] (mpewitt@utk.edu), H. Y. McSween[1], Raymond Doherty[2], and L. A. Taylor[1], [1]Planetary Geoscience Institute, Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN, 37996, USA, [2]4441 W Main Street, Tupelo, MS 38801, USA.

Introduction: Enstatite chondrites are the rarest and most reduced chondrite clan [1]. E-chondrites are subdivided into two groups, EL and EH, based on modal iron-metal abundances. E-chondrites are characterized by the presence of nearly pure enstatite and silicon-bearing metal, with ferroan-alabandite in EL and niningerite in EH. Additionally, elements that are typically lithophilic in most meteorite groups (e.g., Mn, Mg, Ca, Na, K) can behave like chalcophile elements in the E-chondrites due to the extremely reducing conditions, forming a variety of accessory phases. Metamorphic characteristics used to define petrologic types [2] do not apply well to E-chondrites; therefore, mineralogic types are utilized to specify metamorphic grade [3].

The 280g Tupelo meteorite was found in 2012 by Maura O'Connell and Raymond Doherty, in a field in Mississippi while looking for Indian artifacts. Based on mineralogic and petrographic examination, we have determined it to be an enstatite chondrite, classifed as EL6. Tupelo is one of 70 known EL6 chondrites, officially named in December 2012 by the Meteoritical Society.

Physical and Petrographic Characteristics: The outer surface of the meteorite is covered by a fusion crust. The fresh surface is dark grey with reflective bits of metal easily seen with the unaided eye. In thick sections, a few relic chondrules (≤2mm) are visible but are overall poorly defined, and most chondrules are not readily discernible. The lack of chondritic texture, due to intergrowth with the matrix, is the result of metamorphism [4].

Methodology: A 0.2g sample of the specimen was cut from the main mass and four polished thick sections were prepared, M1-M4. Sections M1 and M3 were selected for detailed analysis. DRD and MLP performed independent analysis and results were then compared and combined to provide a more representative dataset. Mineral compositions were determined using the Cameca SX-100 electron microprobe. Modal abundances of metal, silicates, and sulfides were calculated using BSE images and ENVI Image Analysis Software.

Results and Classification: The major mineral phases of the Tupelo chondrite are silicates, sulfides, phosphides, and metal. Modal analyses of the two analyzed sections are given in Table 1. The kamcite/silicate ratios of both sections are consistent with EL chondrites.

	Silicates	Kamacite	Troilite**	Other*	Kam/Sil
EH mean	**61.4**	**25.6**	**10.8**	**2.14**	**0.42**
2σ	**5.99**	**8.52**	**5.42**	**1.89**	**0.17**
EL mean	**68.4**	**17.7**	**10.0**	**3.99**	**0.26**
2σ	**8.76**	**11.8**	**5.04**	**4.56**	**0.19**
Tupelo (M1)	73.6	12.0	6.11	8.31	0.16
Tupelo (M3)	72.5	12.6	6.20	8.74	0.17

After Zhang et al. 1995

Table 1. Modal analyses of Tupelo after [3]. * include graphite, schreibersite, and all other non-sulfide, non-silicate minerals present. **Troilite also includes alabandite and daubreelite.

The silicates are nearly FeO-free enstatite (En_{98}) and sodic plagioclase feldspar ($Ab_{77.7}Or_{4.8}$). This feldspar composition is consistent with composition reported by [4] for petrologic type 6 chondrites. Kamacite is the most abundant opaque mineral; its nickel content (average 5.5 wt %) is consistent with EL chondrites (Fig. 1). The silicon content of the kamacite (average 0.92 wt %) is consistent with EL5-EL6 chondrites (Fig. 2). The sulfides are dominated by Ti-bearing troilite, of composition ($Fe_{0.965}Cr_{0.019}Mn_{0.001}Ti_{0.013}$)S, consistent with an EL6 classification (Fig. 3). Two cubic monosulfides are present in this meteorite. Ferroan alabandite of composition ($Mn_{0.718}Fe_{0.226}Mg_{0.045}Ca_{0.004}Cr_{0.007}$)S and the calcium sulfide, oldhamite. Ferroan alabandite is a distinguishing sulfide found exclusively in EL chondrites (Fig. 4). Oldhamite was detected using energy dispersive x-ray spectroscopy, but the few grains encountered were too small to analyze quantitatively. Another accessory sulfide commonly associated with troilite in this sample is daubreelite. Daubreelite often occurs as lamellae and broad bands within troilite grains [4], consistent with the findings in Tupelo. The daubreelite is compositionaly close to its ideal formula $FeCr_2S_4$, with the exception of minimal substitution of manganese (averaging 2.18 wt %) and titanium (averaging 0.09 wt %). The phosphide mineral, schreibersite, $(Fe,Ni)_3P$, was found to have slight compositional zoning in nickel content. The core composition is higher in nickel than the rim composition (24.2 versus 23.8 wt %, respectively). This composition corresponds to EL6 chondrites (Fig. 1). Graphite was detected using energy dispersive x-ray spectroscopy. The graphite is found occurred as inclusions within larger grains of kamacite.

Four mineralogic types (i.e., α, β, γ, δ) have been defined by [3] to yield approximately equal divisions and maintain *Van Schmus and Wood's* [2] petrologic types for enstatite chondrites. The mineralogic types are defined by four cation relationships, as illustrated in Figs. 1-4. Plotting our average mineral compositions on the diagrams of Zhang et al. [3] (replotted using Zhang's tabulated analyses), we conclude that Tupelo is an EL6β chondrite.

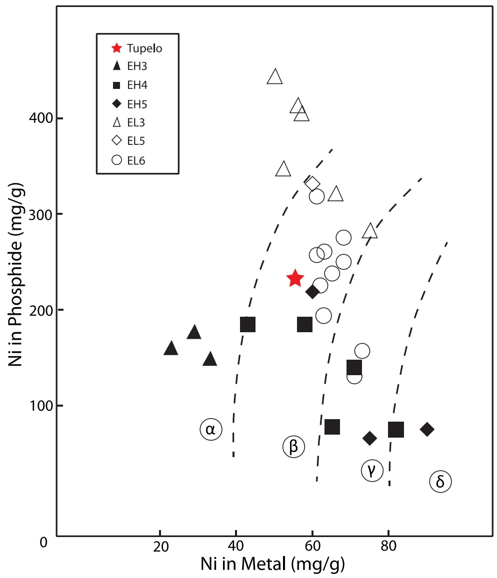

Figure 1. Average composition of schreibersite in Tupelo after [3]. Figure shows Ni in phosphide vs. Ni in metal ratio in agreement with EL6.

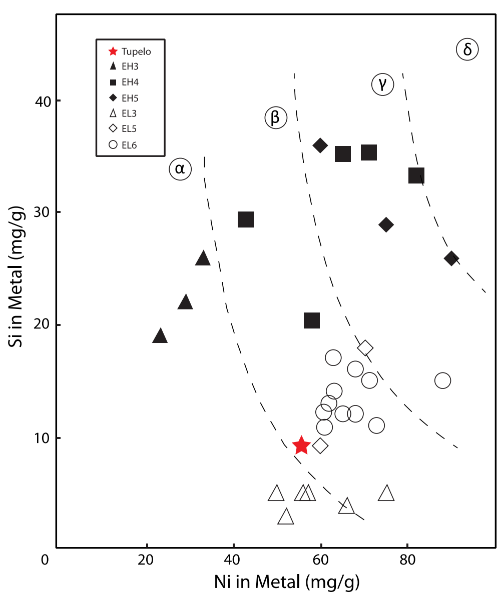

Figure 2. Average composition of metal in Tupelo after [3]. Figure shows Si in metal vs. Ni in metal ratio in agreement with EL5 and EL6 chondrites.

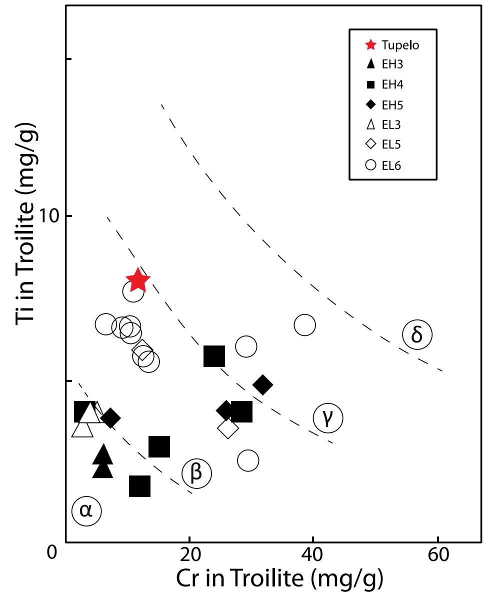

Figure 3. Average composition of troilite in Tupelo after [3]. Figure shows Ti in troilite vs. Cr in troilite ratio confirming EL6.

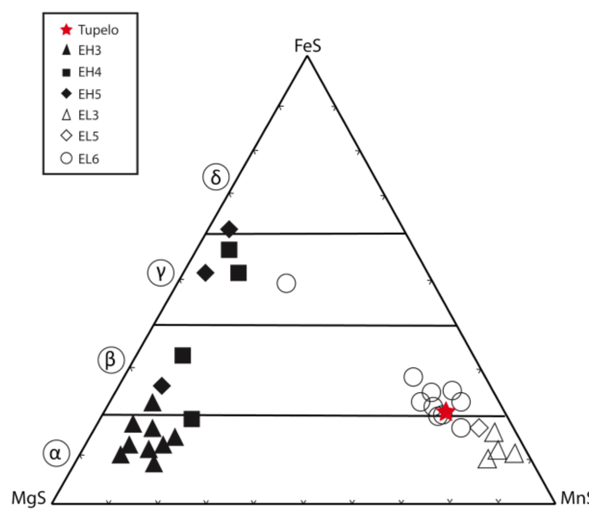

Figure 4. Ternary diagram for Fe/Mn/Mg sulfides (mole%) in Tupelo compared to [3]. Sulfide mole % shows Tupelo agreement with EL6β classification.

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