THERMOLUMINESCENCE AND THE METAMORPHIC HISTORY OF THE CO CHONDRITES. Bradly D. Keck and Derek W. G. Sears, Department of Chemistry, University of Arkansas, Fayetteville, AR 72701.

The CO chondrites are mineralogically and petrologically similar to the type 3 ordinary chondrites and also show evidence for a metamorphic sequence (1). The thermoluminescence (TL) sensitivity of the type 3 ordinary chondrites is highly dependent on the levels of metamorphism they have suffered. This is probably because metamorphism causes the formation of the TL phosphor, feldspar, through the devitrivication of primary igneous glass (2-5). McSween observed that in the CO chondrites feldspar also appeared, and glass disappeared, as metamorphism proceeded (1). Other properties of the TL glow curve, peak temperature and peak width, are related to the thermal history of the ordinary chondrites (6). Petrologic types 3.3-3.5 have TL peaks at 120-140 C, while types 3.6-3.9 have TL peaks at 180-220 C; these differences in peak temperature have been attributed to solid state changes in the feldspar (the order/disorder transformation) and have paleothermometry and cooling rate implications (6,7).

The TL properties of duplicate chips of Isna, ALHA77003, ALHA77307, Kainsaz, Lance, Ornans, Felix and Colony, and a single chip of Warrenton, were measured using the techniques of Sears and Weeks (14). ALHA77307 and Colony display several unusual features which have led to uncertainty concerning their classification (8-12), however, since they are undoubtedly related to the CO class, these meteorites were included in the present study. Unlike the ordinary chondrites, which show a single broad peak between 100-250 C, the CO chondrites show peaks at 130+/-5 C and 250+/-5 C, while 77307 and Colony displayed a peak at 350+/-8 C (uncertainties are 1 sigma). The intensity of the 130 C peak varies over 2 orders of magnitude (Fig. 1) and correlates with olivine heterogeneity (Fig. 2), McSween's metamorphic sub-types I-III (I least, III most metamorphosed), and concentrations of Cr, Ni and Co in the kamacite. The intensity of the 250 C peak is relatively uniform, except for Colony which is lower, and is not metamorphically related. The intensity of the 350 C peak in Colony is 1/20 that of 77307.

The CO chondrites differ from the ordinary chondrites in their abundance of amoeboid inclusions which are expected to contain several TL phosphors (13). There is a weak correlation between TL sensitivity and amoeboid inclusion abundance, however normalizing the TL sensitivity values to the abundance of amoeboid inclusions improves the correlation between TL sensitivity and olivine heterogeneity, suggesting that amoeboid inclusion abundance is not the major cause of TL sensitivity variation. Mineral separation experiments performed on Isna showed that the light fractions are a factor of two higher TL sensitivity than the heavy fractions. There was no indication that the minerals responsible for the 130 and 250 C peaks could be separated on the basis of density. An annealing experiment (1 week at 900 C) caused the 130 C peak to merge with the 250 C peak (a behavior similar to that observed for ALHA77011 (6)).

The data are consistent with the phosphor in the CO chondrites being feldspar and the 130 C peak being due to the ordered (low-temperature) form. In this case, the relationship between the 130 C peak and metamorphism reflects its formation by the devitrification of glass below the order/disorder transformation temperature (about 600 C). We infer metamorphic equilibration temperatures of 400-450 C from the metal compositions of McSween (1). It is significant that the 130 C peak is more intense in the CO chondrites than it is in the ordinary chondrites, which implies slower cooling rates for the CO class. If the 250 C peak reflects the presence of high-temperature feldspar, then the uniform TL sensitivity values for this peak indicates that it was not produced during metamorphism. The cause of the 350 C peak is currently unknown, although cathodoluminescence studies on particularly primitive type 3 ordinary chondrites show that a great many diverse phosphors are present in the most primitive meteorites (5).

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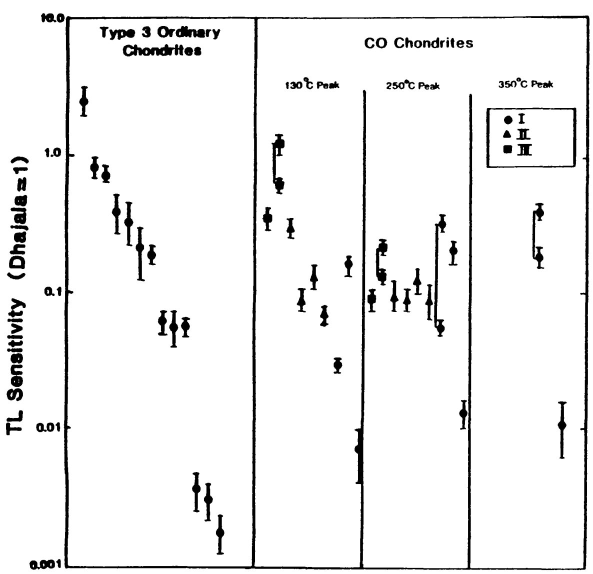

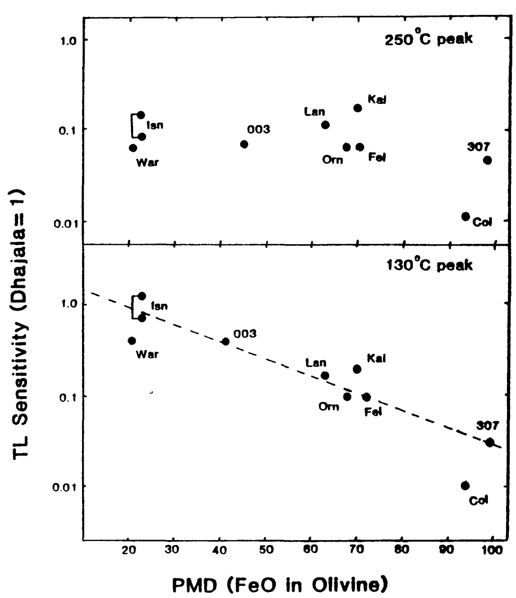

Fig. 1. (left) TL sensitivities of the CO chondrites compared with those of the type 3 ordinary chondrites. I, II and III refer to McSween's petrologic subtypes (1). Fig. 2. (right) TL sensitivity vs. olivine heterogeneity in CO chondrites. The TL sensitivity of the 130 C peak is inversely correlated with several other quantites probably related to metamorphism, while the 250 C peak shows no such relationships.