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PYROXENE EQUILIBRATION TEMPERATURES IN METAMORPHOSED ORDINARY CHONDRITES. R.P. Harvey, M. L. Bennett, and H.Y. McSween Jr. Department of Geological Sciences, University of Tennessee, Knoxville, TN 37996-1410.

Ordinary chondrites are divided into petrographic types based on observed mineralogical and textural properties consistent with progressive thermal metamorphism from low grade (type 3) to high (type 7). Regardless of the exact cause of the metamorphism, higher-type chondrites should retain information concerning peak temperatures reached and for what duration. Using the two-pyroxene geothermometer of Lindsley [1], we have calculated the equilibration temperatures for 26 H, L and LL type 5 and 6 ordinary chondrites, to investigate the relative peak temperatures and equilibration-states reached by these various meteorite classes.

The Lindsley thermometer relies on a detailed accounting of non-quadrilateral components in pyroxenes, whose recalculated compositions are then plotted onto an empirically-derived polythermal diagram from which temperatures can be interpolated. The reported uncertainty of this method is ± 50°C; in addition, close spacing of isotherms on the graph (particularly for orthopyroxene compositions) increase this uncertainty. We have parameterized the Lindsley polythermal quadrilateral for 1 atm pressure (< 2 bar), and interpreted recalculated coordinates directly in terms of 25°C temperature intervals. Meteorites selected for this study include both relatively shocked and unshocked specimens; heavily weathered or visibly brecciated specimens were avoided. Temperatures were calculated from orthopyroxene (opx) and clinopyroxene (cpx) analyses within one relative percent of ideal sums and stoichiometry.

Histograms summarizing the calculated temperatures for type 5 and 6 ordinary chondrites are shown in Fig. 1. The uncertainty mentioned above corresponds roughly to one 25°C-wide bin in either direction. Temperatures indicated to be >1200°C, corresponding to chondrule crystallization temperatures rather than metamorphism, were not included in the summary statistics. Antarctic and non-Antarctic H chondrites were treated as separate groups to investigate the possibility that they have had different thermal histories. Cpx temperatures for all classes of type 6 ordinary chondrites show a mean temperature of 919°C (Fisher, an L6 showing anomalously low cpx temperatures, was not included in the cpx statistics). Similarly, opx in type 6 show a mean of 799°C. Cpx shows temperatures consistently higher than opx, as noted by [2]. Type 5 ordinary chondrites show a mean temperature of 946°C for cpx and 786°C for opx. The cpx temperature distributions all show a spread of values around a central peak; in addition, these peaks occur within 1 σ of each other and thus are consistent with equilibration to a single temperature for both type 5 and 6 near 925°C. Opx temperature distributions show a similar relationship at lower temperatures. Our temperatures are consistently higher than those previously reported for cpx in L6, LL6 and H6 meteorites by [3]. No significant difference between the Antarctic and non-Antarctic groups was noted.

Chondrule crystallization temperatures for pyroxenes are generally quite high; cpx in type 3 ordinary chondrites rarely give temperatures below 1200°C. Therefore the temperatures given by pyroxenes represent attempts to equilibrate downward to lower temperatures. The resulting temperature distribution reflects the rapidity of cooling and the duration of exposure to peak temperatures. The type 6 temperature distributions have lower σ's and are more symmetrical than those shown by type 5, suggesting that type 6's experienced a longer time at peak temperature and less time at lower temperatures; i.e., faster cooling. Similarly, the higher σ shown by type 5 ordinary chondrites may represent the same peak temperature, but with less time spent at the peak and more gradual cooling, allowing equilibration to lower temperatures. This apparent relationship between petrographic type and cooling rate (higher petrographic types experiencing faster cooling) is contrary to that predicted by standard onion-shell models for ordinary chondrite parent bodies. Type 6 meteorites also do not appear to have reached a higher temperature than type 5, as predicted by onion-shell models. The concordance of the peak temperature across compositionally distinct classes suggests that metamorphism affected all types of parent bodies to the same level. Future expansion of our database, studies of equilibration in opx and cpx, and application of independent thermometers and cooling rate speedometers will all have a strong bearing on these hypotheses.

References: [1] D.H. Lindsley (1983) *Am.. Mineralogist* **68**, 477-493. [2] H.Y McSween, Jr. and A.D. Patchen (1989) *Meteoritics* **24**, 219-226. [3] E.J. Olsen and T.E. Bunch (1984) *Geochim.. Cosmochim. Acta* **48**, 1363-1365.

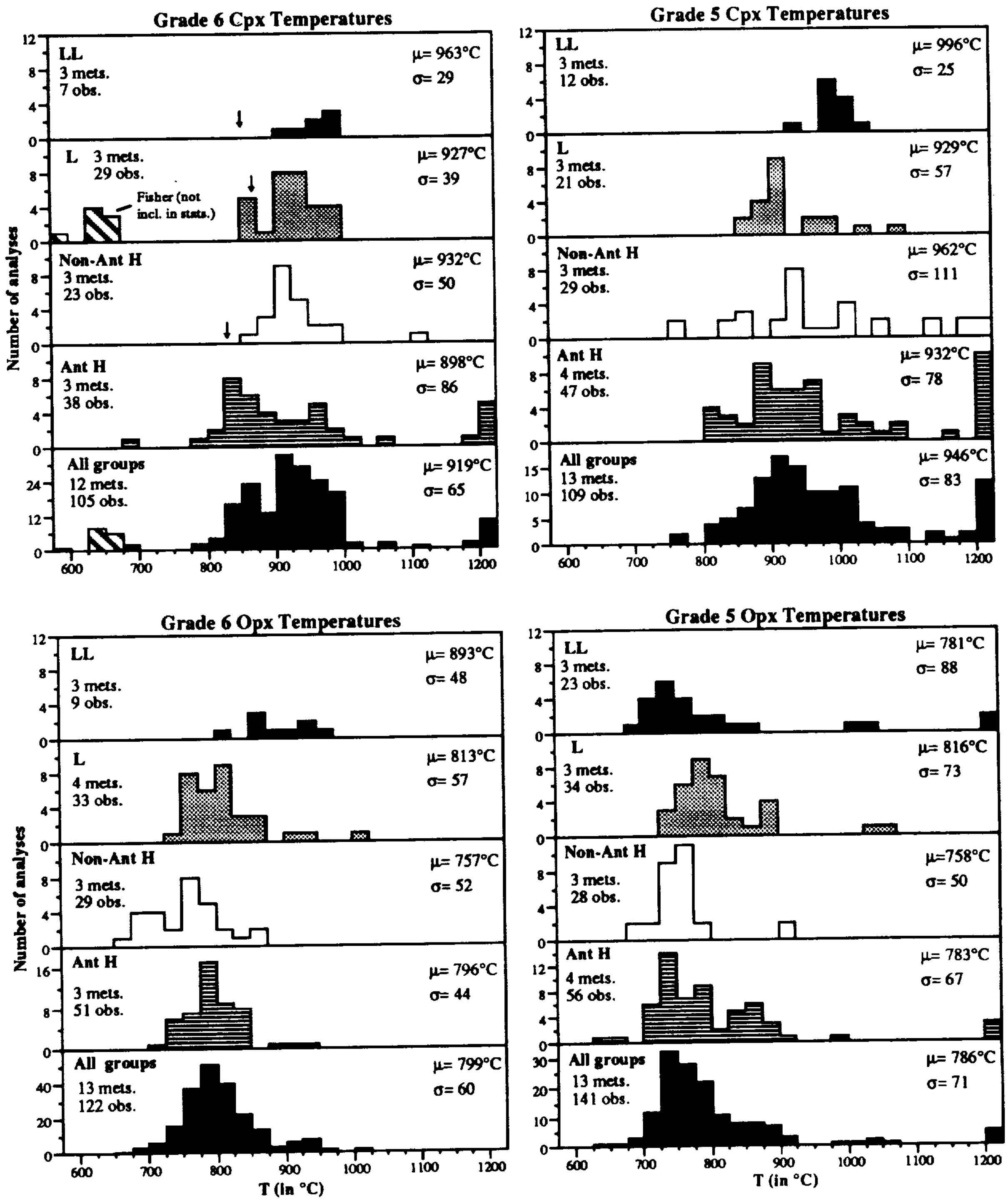

Figure 1. Temperature distribution histograms for petrographic grade 5 and 6 LL, L and H ordinary chondrites. Each bin along the X-axis represents a 25°C temperature interval. Arrows show mean temperatures for LL6, L6 and H6 groups reported by [3].