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METAMORPHISM VERSUS AQUEOUS ALTERATION IN TYPE 3.0-3.3 ORDINARY CHONDRITES

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There is considerable evidence that the type 3.0-3.2 ordinary chondrites differ in some fundamental way from the higher petrologic types. Since the properties that distinguish the type 3.3 from the higher types is due to different levels of metamorphism, it has been commonly assumed that the types 3.0-3.2 are the least metamorphosed ordinary chondrites known, and thus the "most primitive" (Sears *et al.*, 1980). Type 3.0-3.2 chondrites have the lowest TL sensitivities and do not lie on the TL sensitivity vs. peak temperature and peak width trends displayed by the higher types (Sears *et al.*, 1982; Sears and Weeks, 1983). They also have unique cathodoluminescence (CL) properties as minerals other than feldspar, which is the dominant phosphor in type > 3.3, are the major sources of CL, and TL, in these lower petrologic type meteorites (DeHart and Sears, 1986). Semarkona shows much evidence for aqueous alteration (Hutchison *et al.*, 1985); stepwise heating releases water of unusual isotopic composition (McNaughton *et al.*, 1983), the matrix contains lines of calcite and some chondrules have been attacked to produce a material which give low sums upon electron microprobe analysis. We report here on a series of hydrothermal annealing experiments which demonstrate that the type < 3.3 ordinary chondrites may have been subject to aqueous alteration, while the higher types have suffered only metamorphism.

Semarkona (3.0), Allan Hills A77214 (3.4), Sharps (3.4) and Dhajala (3.8) were annealed at 450-900°C for 10-500 h, at pressures of 0.77-1.0 kbar (Lofgren, 1971; Lofgren *et al.*, 1985; Guimon *et al.*, 1986a, 1986b). Various amounts of water and sodium disilicate were added to catalyze the devitrification process thought to be responsible for the metamorphism-induced TL increase. We found that low temperatures and short annealing times produced a decrease in TL sensitivity, while longer annealing times and higher temperatures produced an increase in TL sensitivity. The decrease occurred in samples with no sodium disilicate added, and we assume that it is due solely to the presence of water and the heating. The times and temperatures at which these changes occurred varied from sample to sample, but the decrease was greater for the samples with higher pre-annealing TL sensitivities. We suggest that two processes are occurring in our experimental charges; at low temperatures destruction of the phosphor is occurring by aqueous processes, while at high temperatures the phosphor is being created by the devitrification of chondrule glass. The glow curves produced by low temperature annealing of the type 3.4 samples resemble those of the Semarkona meteorite. The data indicate that it is possible that the truly "primitive" meteorites are type 3.3, and that higher types have suffered metamorphism, while lower types have suffered aqueous alteration. Anders and Zadnick (1985) have pointed out that several type 3.4 chondrites have more CI-like contents of volatile elements than several type 3.0 chondrites, consistent with a more "primitive" nature.

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