PROXY SOLAR CYCLICITY RECORDED IN GRAIN SIZES OF VARVED SEDIMENTS;

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It has been suggested that cyclical banding within certain sedimentary deposits may reflect variations in solar output with time. One such deposit is the late Precambrian Elatina Formation of Pichi Richi Pass, southern Australia (1,2). Elatina samples exhibit periglacial varves whose thicknesses show a remarkable cyclicity which has been interpreted as a record of solar activity. An individual varve is composed of a light-dark laminae couplet, and there are eleven to twelve varves contained between two "dark bands". The proposed mechanism by which these laminae recorded solar conditions involves a coupling between the sun and the strength of glacial meltwater runoff feeding sediment to an ancient lacustrine system. Our investigations of the grain sizes contained in these varves indicate a close correlation between the runoff energy in the feeding streams, and the resulting laminae thicknesses. This demonstrates that the varve thickness is indeed indicative of stream activity and supports the glaciolacustrine portion of the proposed mechanism. An alternate hypothesis suggests that this banding was produced by lunar tides. However, tidal flat facies are usually characterized by well-sorted, well-rounded grains and typically exhibit flaser bedding (3); these are not observed within the Elatina samples. Other sedimentological evidence has also been cited (4) which is inconsistent with a tidal origin.

A thin section of the Elatina sample was used for sedimentological analysis. Of particular interest was the grain size distribution within individual laminae. The grain studies were performed for two sections (both about one square centimeter) each of which spanned the region between two successive dark bands. One of these areas comes from a particularly narrow dark band, and the other was chosen from a wide dark band. The regions are outlined in figure 1. Up to 19 photographs were made by traversing these sections and the grains were counted along traverses within a half photograph (ie two counts were made on each photograph). Although these count areas were nearly the same size as the varves, the count boundaries did not exactly correspond to varve delineations. Grain size means thus artificially tended toward uniformity by including more than one lamina. Maximum grain sizes are plotted rather than mean values in the accompanying figures.

Tentative analysis has been completed, but more detailed observation is still proceeding as of this writing. Figure 2 shows the maximum grain sizes found for the narrow region, and figure 3 for the wide region. Within a given region there are two important features. First, there is an alternating large, small grain size pattern which corresponds to the alternating light, dark appearances of the varves. The lighter the varves, the larger the grain sizes. Large grains suggest that the light regions are the result of high runoff energy during the summer season. Second, there is a generally convex pattern to the maxima in the graphs which implies a corresponding trend in the flow strength of summer runoff through time; beginning at one of the dark bands, subsequent summers have increasingly intense runoffs which peak and then decline again to their original

conditions in eleven to twelve years. Notice also that the grain sizes in the wide dark band region are generally larger than their counterparts from figure 2. This is similar to the relationship seen in the light bands, where large grain sizes in the annual layers correspond to wide laminae. Some spurious effects due to varve overlap within half photograph counts can be seen in the figures (eg data point five in figure 3) but do not appreciably detract from the overall patterns noted above.

Conclusions: Preliminary conclusions that can be drawn from these studies include the following: 1) the alternating light, dark appearance of the laminae is due to similar alternations in the grain sizes suggesting summer, winter runoff seasons, 2) variable thicknesses between individual laminae corresponds to grain size differences between the laminae, 3) variable thicknesses between dark band cycles also correspond to grain size differences, 4) the grain size plots follow a generally convex form within each dark band cycle. Subsequent investigation is expected to reaffirm these findings as well as search for evidence which could rule out (or substantiate) a tidal origin for the varves.

References: (1) Williams, G. E. and C. P. Sonett, 1985 *Nature* 318, 523. (2) Sonett, C. P. and G. E. Williams, 1987 *Solar Physics* 110, 397. (3) Leeder, M. R., 1982 *Sedimentology: Process and Product*. 344p., Allen and Unwin Ltd. (4) Williams, G. E. 1982 *EOS* 63 (39) p. 794

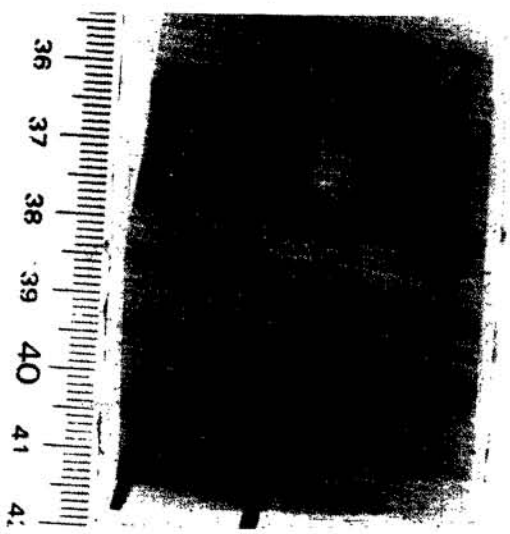

Figure 1

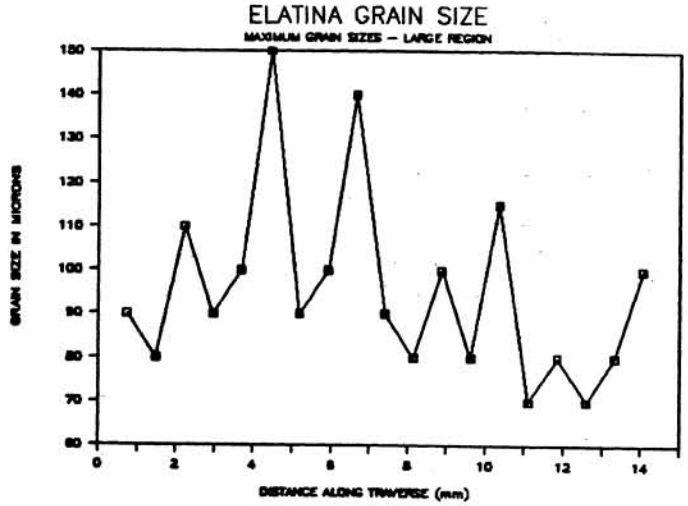

Figure 2

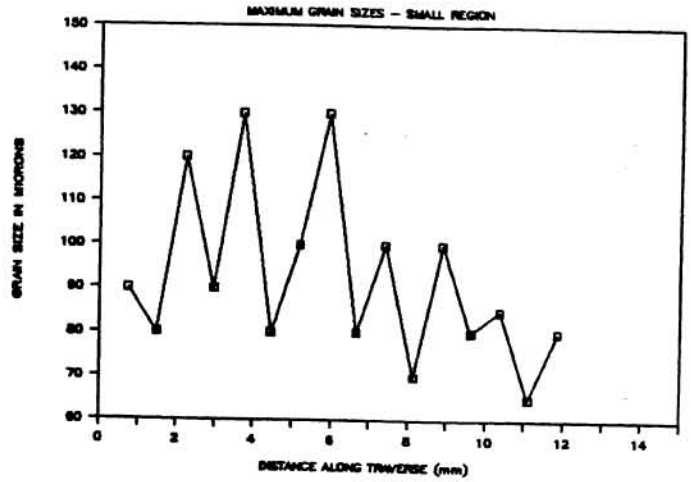

Figure 3

Supported by NSF Solar-Terrestrial program.