PRELIMINARY REPORT ON THERMOLUMINESCENCE OF LIMESTONES FROM THULE, GREENLAND AND WARD HUNT ISLAND ON ELLESMERE ICE SHELF *

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Introduction

Thermoluminescence studies can provide information concerning the past thermal environment of naturally occurring rocks and minerals. The possibility of obtaining such information arises from the fact that the accumulation of natural thermoluminescence depends on both the natural radiation rate, which is a measurable quantity in most carbonate samples, and the ambient temperature of the rock, which is an unknown quantity related to average climatic temperatures extant during the accumulation.

Light is emitted from a thermoluminescent mineral when electrons make a transition from trapped positions to normal positions within the crystal lattice. Electron traps are theoretically identified with lattice imperfections resulting from negative ion vacancies or from impurity ion inclusions within the crystal structure. The initial displacement of electrons into traps is accomplished by high energy radiations, particularly by alpha particles from radioactive impurities. In nature, the energy required to release electrons from their traps is provided by the thermal environment of the mineral.

Low-temperature peaks occur in the natural glow-curves of those thermoluminescent minerals in which an equilibrium has been established between the natural radiation rate and the ambient temperature. A rise in the maximum temperature to which the mineral is subjected will cause electrons to be slowly drained from low-temperature traps and will result in a reduction of thermoluminescence in the low-temperature range. Conversely, a decrease in ambient temperatures will allow more electrons to accumulate in low-temperature traps, and low-temperature peaks will become more pronounced.

Samples

A total of 5 samples were collected at Thule and 7 samples at Ward Hunt Island between September 6 and September 16, 1959. Owing to surface heating effects which were encountered in working with Antarctic rocks, much care was exercised in collecting these samples. All were taken from as far below the outcrop surface as it was possible to dig with the equipment available.

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Samples were transported in a specially insulated refrigeration cask. Dry ice was not available at Thule, but samples were stored in a refrigerated warehouse at approximately +5°F. Polyethelene bottles of frozen brine were used to keep the cask cold and appear to have worked satisfactorily.

Results

Immediately upon arrival at the laboratory all samples were ground, and glow-curves were run. Two of the five samples collected at Thule and three of the seven samples collected on Ward Hunt Island showed low temperature thermoluminescence. The existence of low temperature thermoluminescence in these samples indicates that they have remained at reduced temperatures for an extended period of time. Studies of the decay rate of the naturally occurring low temperature peak show that at 25°C the half-life of the peak is approximately 25 hours.

At the time of preparation of this preliminary report determinations of the actual age of refrigeration have not been completed. Calculations require data concerning the natural radioactivity and the luminous efficiency of the samples. Determinations of natural radioactivity by alpha scintillation counting have been made but quantitative measurement of luminous efficiency has not been completed. Until all of these measurements are made it will not be possible to estimate the age of refrigeration of the arctic areas from which the limestones were taken. At the same time, any assumption that climatic conditions were warm enough to melt the permafrost at Thule or Ward Hunt Island in the recent past would seem unwarranted in view of these results.