

AGE DETERMINATION OF A GLACIAL ERRATIC IN COLUMBUS, OHIO^{1, 2}

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ABSTRACT

The age of a large glacial erratic boulder located in front of Orton Hall on The Ohio State University campus was measured by the whole-rock Rb-Sr method and was found to be 998 ± 82 million years. This date falls within the time interval of the Grenville Orogeny and suggests that the boulder originated from the Grenville Province of the Precambrian Shield of Canada.

INTRODUCTION

A prominent landmark on the campus of The Ohio State University is a large boulder of granitic composition located in front of Orton Hall at 155 South Oval Drive in Columbus, Ohio. According to reports published in the Ohio State Lantern (Williams, 1959; Peters, 1971, Figure 2), the boulder was discovered in 1905 at the corner of 16th and Iuka Avenues at the site of the present Wesley Foundation. Dr. Edward Orton, Jr., saw the boulder and arranged to have it moved to the campus. The original location of this boulder was within surface till referred to by Morse (1907). There is little doubt that it is a glacial erratic, probably deposited during the main, or classical Wisconsin Stage of the Pleistocene Epoch.

The age of this rock was determined by the whole-rock Rb-Sr method in order to identify its source region on the Canadian Precambrian Shield. As a result of the large number of age determinations by the Canadian Geological Survey, the Precambrian Shield of Canada has been subdivided into a number of orogenic and tectonic provinces within each of which the rocks have characteristic dates (Wanless, *et al.* 1970, and preceding Annual Reports). This makes it possible to trace glacial erratics in the mid-western states of the U.S.A. to their source regions with reasonable confidence on the basis of age determinations. Insofar as we are aware, this is the first attempt to use an age determination of a glacial erratic for this purpose.

ANALYTICAL PROCEDURES AND RESULTS

A core sample, one inch in diameter and about two inches long, was cut from near the base of the boulder. The outer, weathered portion of this core was removed and a thin section of the unweathered interior was cut for petrographic examination.

The rock has a porphyritic, allotriomorphic-granular, cataclastic texture. It consists of coarse crystals of plagioclase and perthitic microcline (up to 3 cm in length) surrounded by a fine to medium-grained granitoid matrix of quartz, plagioclase and microcline. Patches of mafic material, principally composed of hornblende, biotite, and magnetite, with some sphene and zircon, also occur in the matrix. The crystals of quartz have strongly undulose extinctions, giving them a "mosaic" appearance under crossed nicols. Plagioclase twin lamellae are frequently bent, and both plagioclase and microcline crystals have strained extinctions. On the basis of its mineral composition, the rock is classified as a porphyritic granodiorite or quartz monzonite (Williams, Turner, and Gilbert, 1955). A more specific classification of this rock would require a modal analysis, which is made difficult by the coarse texture of this rock.

¹Laboratory for Isotope Geology and Geochemistry Contribution No. 20.

²Manuscript received July 3, 1971.

The unweathered portion of the core was crushed in a steel mortar until all of the powder passed a screen of mesh-size 120. The powdered rock was homogenized and aliquots were taken for analysis of the concentrations of rubidium and strontium, and of the $^{87}\text{Sr}/^{86}\text{Sr}$ ratio. Concentrations of rubidium and strontium were measured by x-ray fluorescence using a Mo target x-ray tube and a LiF (220) analyzer crystal with a General Electric Co. Model XRD-6 X-ray instrument. Calibration was by means of U.S. Geological Survey rock standards (W-1, GSP-1, and G-2). Matrix corrections were made by means of the Compton-scattered Mo k-alpha x-ray peak. The calibration curves were linear, and the standard deviations of their slopes were less than $\pm 2\%$ for both rubidium and strontium. The results, based on four replicate determinations for each element, are presented in Table 1, and include an estimate of the reproducibility of the measurement, expressed as one standard deviation. Based on these measurements, the Rb/Sr ratio was found to be 0.1830 ± 0.0032 . The precision of this value was improved by making 15 additional replicate determinations of the Rb/Sr ratio, reducing the error to ± 0.0025 (Peters, 1971).

In order to measure the $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of this rock, a 0.5-g aliquot of the powder was digested in a mixture of reagent-grade HF and H_2SO_4 in a Teflon dish. The residue was dissolved in dilute Vycor-distilled HCl and strontium extracted by means of cation-exchange chromatography using Dowex 50-X8, 200-400 mesh, cation-exchange resin, and 2.25N Vycor-distilled HCl as eluant. The strontium was analyzed on a Nuclide Corp. Model 6-60-S mass spectrometer. The measured value of the $^{87}\text{Sr}/^{86}\text{Sr}$ ratio was corrected for isotope fractionation to a standard value of the $^{86}\text{Sr}/^{88}\text{Sr}$ ratio of 0.1194. The reproducibility of the corrected $^{87}\text{Sr}/^{86}\text{Sr}$ ratio is estimated to be ± 0.0005 , based on replicate analyses of the Eimer and Amend SrCO_3 isotope standard in this laboratory.

DISCUSSION

The measurements listed in Table 1 can be used to calculate the age of the

TABLE 1
Analytical Results of Glacial Erratic, Orton Hall, OSU Campus

Sample	Rb ppm	Sr ppm	Rb Sr	$\left(\frac{^{87}\text{Sr}}{^{86}\text{Sr}}\right)_{\text{corr.}}$	$\frac{^{86}\text{Sr}}{^{88}\text{Sr}}$
515	89.4 ± 1.1	488.3 ± 6.0	0.1830 ± 0.0032	0.7114 ± 0.0005	0.1188

rock by substitution into an equation which is derivable from an application of the law of radioactivity to the decay of ^{87}Rb to ^{87}Sr in rocks or minerals. This equation states that

$$\left(\frac{^{87}\text{Sr}}{^{86}\text{Sr}}\right) = \left(\frac{^{87}\text{Sr}}{^{86}\text{Sr}}\right)_0 + \frac{^{87}\text{Rb}}{^{86}\text{Sr}} \left(e^{\lambda t} - 1\right), \quad (1)$$

where $(^{87}\text{Sr}/^{86}\text{Sr})_0$ is the value of this ratio at the time of formation of the rock ($t=0$) and λ ($= 1.39 \times 10^{-11} \text{ yr.}^{-1}$) is the decay constant of ^{87}Rb . In order to solve this equation for t , it is necessary to assume a value for $(^{87}\text{Sr}/^{86}\text{Sr})_0$. We have chosen to set this ratio equal to 0.7040 ± 0.0020 , which includes the $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of most basaltic rocks of mantle origin (Gast, 1967). The date calculated in this way implies the assumption that the strontium in this rock did not reside in sialic rocks of the continental crust for an appreciable period of time before

being incorporated into this rock. The date obtained from a solution of equation (1) is 998 ± 82 million years. The limits of uncertainty of the date were calculated from the experimental errors of the measurements, but do not include the uncer-

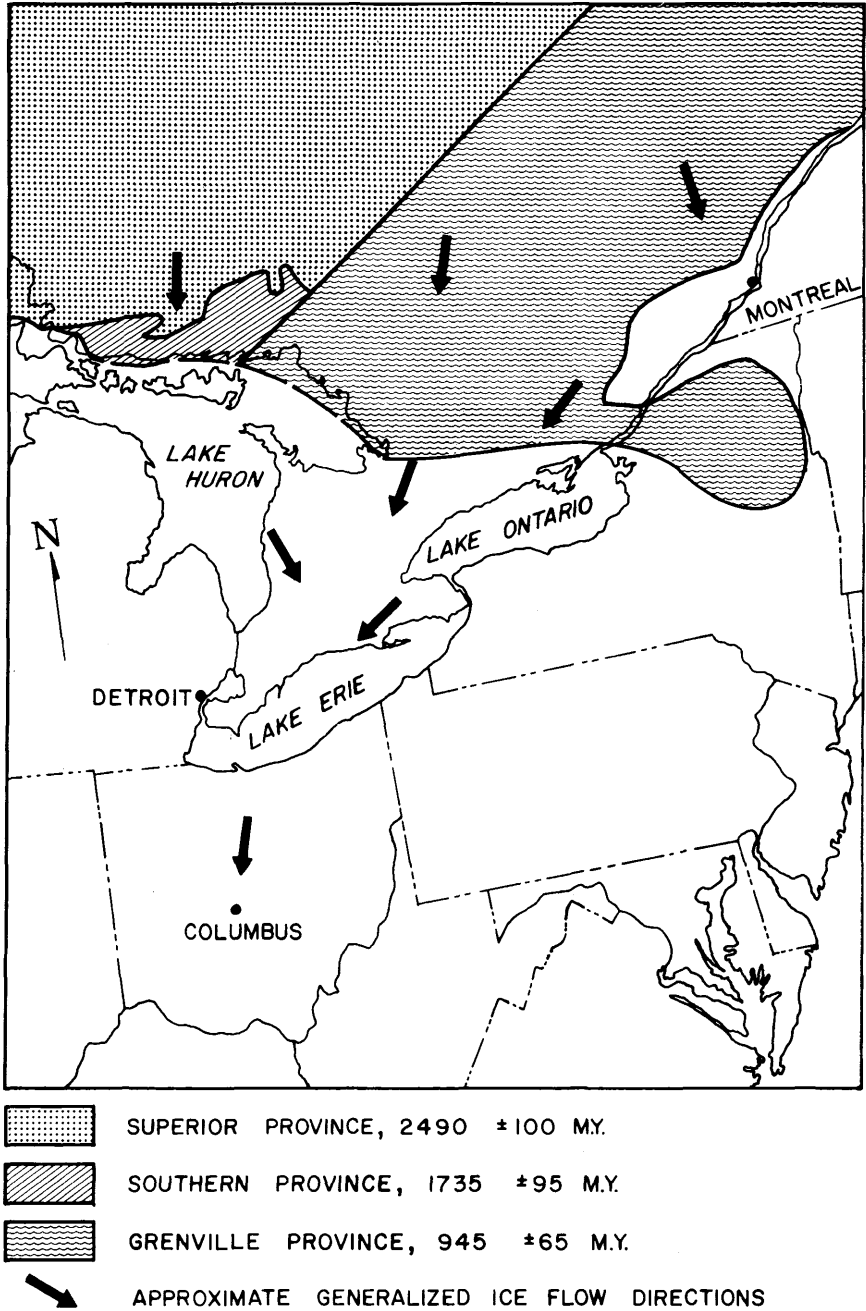


FIGURE 1. Approximate and generalized ice flow directions of Wisconsin ice in relation to the major tectonic provinces of the Canadian Precambrian Shield in parts of Ontario and Quebec (ice-flow directions adapted from Prest, *et al.*, 1970).

tainty in the estimate of the initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio. The results indicate that this rock crystallized approximately one billion years ago.

Age determinations by Wanless *et al.* (1970) have provided evidence that magmatic activity and high-grade regional metamorphism occurred in western Ontario and Quebec during the Grenville Orogeny 945±65 million years ago. The region affected by these geological events is known as the Grenville Province and is shown in Figure 1. The age of this boulder is well within the time interval during which the Grenville Orogeny occurred and we conclude that this erratic most likely originated from the Grenville Province of Canada.

It is very probable that the erratic was deposited during the retreat of the Scioto lobe of Wisconsin ice. Ice-flow directions in Canada and Ohio, indicated schematically in Figure 1, have led to the widely accepted view that the ice flowed southwesterly across the Grenville Province into the basins of Lakes Ontario and Erie, from whence it moved south. The above interpretation, that this erratic originated within the Grenville Province of the Canadian Shield, is consistent with this view.

More precise location of the source of this boulder within the Grenville Province is not possible without very detailed petrographic comparisons beyond the scope of this report.

ACKNOWLEDGMENTS

We thank Sidney E. White for news clippings from the Ohio State Lantern relating the history of this boulder and for helpful criticism of this manuscript. We also acknowledge the assistance of R. H. Carwile and D. A. McClain in the laboratory. The petrographic description of the thin section was prepared by John Gunner.

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