Technical Papers

Early Pre-Cambrian Carbon of Biogenic Origin from the Canadian Shield

Kalervo Rankama

Institute of Geology,
University of Helsinki, Helsinki, Finland

In a previous paper (*1*), the isotopic constitution of carbon was reported in the suggested pre-Cambrian fossil *Corycium enigmaticum* Sederholm, which occurs in a phyllite at Aitolahti in the Tampere schist belt, Finland. This carbon, because of its isotopic constitution and geologic manner of occurrence, proved to be of biogenic origin, and it was concluded that the *Corycium* is a genuine pre-Cambrian fossil. With an estimated age of 1.5×10^9 yr, the *Corycium* was regarded the most ancient proof of existence of life then known.

While the search was continued for carbon of biogenic origin in rocks still more ancient than the phyllites of the Tampere area, notice was taken of the occurrence of carbonaceous slates of extremely ancient age in the sedimentary series of southeastern Manitoba in Canada. This note announces the results of an isotopic investigation of carbon in five specimens of such slates. A more complete report is in preparation (*2*). The geologic and isotopic evidence serving to disclose the biogenic or nonbiogenic origin of carbon in pre-Cambrian rocks of argillaceous origin was reviewed in another paper (*3*). The conclusion was reached that, in the absence of contradictory geologic evidence, one is entitled to infer that the finely disseminated carbon, even in early pre-Cambrian slates and schists, and the carbonaceous accumulations in such rocks are of biogenic origin if their isotopic constitution falls within the biogenic range—that is, if the $^{12}C/^{13}C$ ratio of such carbon exceeds 90.5.

The carbonaceous slates investigated (*4*) belong to the sedimentary member of the Rice Lake group. The sedimentary member overlies a volcanic member and is the younger of the two (*5, 6*). The Rice Lake group is older than a group of exposed igneous rocks ranging from peridotite to granite in composition that is intrusive into rocks of the Rice Lake group (*7*). All these rocks belong to the Superior province where an over-all age of 2.2×10^9 yr for the intrusive bodies is indicated (*8*). This age is computed from the lead-isotope and strontium ages of uraninite, monazite, and lepidolite from albite pegmatites associated with granites that are intrusive into the Rice Lake-group rocks (*9, 10, 11*). It is supported by independent helium ages of pillow lava and magnetite (*12, 13*). After careful consideration of the accumulated evidence, it appears that an average age of approximately 2.4×10^9 yr is not unreasonably high for the pegmatite minerals, the youngest members of an igneous sequence, and that, consequently, the average age of the igneous complex, with a reasonable margin of safety, is no less than 2.4×10^9 yr. The Rice Lake group represents a previous geologic cycle with a length no less than 0.15×10^9 yr (*9*), and consequently its age is approximately 2.55×10^9 yr.

All the specimens investigated are black dense slates, very rich in finely disseminated carbon and having a more or less well-developed fissility. Some of them are strongly folded, and some are obviously affected by a later hydrothermal alteration. Their degree of metamorphism usually is surprisingly low. All geologic and petrographic evidence indicates that these rocks originally were pelitic sediments, namely, silts and muds containing carbonaceous matter. Notwithstanding their extremely ancient age, the slates are exactly similar to their younger counterparts.

The isotopic constitution of carbon (*14*) in the slates is presented in Table 1. Three of the specimens,

TABLE 1. Isotopic constitution of carbon in slates.

Specimen no.	Description	$^{12}C/^{13}C$
1-A-48	Black slate, shore of Conley Bay, Wallace Lake	90.66
2-A-48	Black slate, same locality	90.86
3-A-48	Black slate, Clangula Lake	90.06
5-A-48	Black slate from a drill core, unknown locality in the Rice Lake district	91.20
C-1-R-50	Black slate, Orogrande Dock, E. of Beresford Lake	90.32

namely, 1-A-48, 2-A-48, and 5-A-48, fall within the biogenic range. The last-mentioned slate, however, probably is from a complex younger than the Rice Lake group. Specimens 3-A-48 and C-1-R-50 that are rather strongly affected by tectonic movements fall below the biogenic range. Because in the Wallace Lake slates carbon lies in the biogenic range, and because these slates, geologically and lithologically, do not differ from their younger counterparts in which the biogenic origin of carbon has been established beyond doubt, the conclusion follows that their carbon is biogenic in origin. This conclusion may be extended to the Clangula Lake and Beresford Lake specimens, even though the evidence appears less convincing. These four slates, however, belong to the same group, and there is no evidence indicating that the slates with the heavier carbon were formed in a way different from the way in which the slates with the lighter carbon were formed.

Consequently, isotopic data supported by geologic evidence indicates that the carbon is of biogenic origin in at least some of the early pre-Cambrian carbonaceous slates from the Canadian Shield. In other words, living organisms were in existence already some 2.55×10^9 yr ago. It is, however, impossible to decide what kind of life the ancient carbonaceous remains in the rocks of the Basement Complex represent. Considering the age of 3.5×10^9 yr of the upper lithosphere (*15*), one is tempted to conclude that conditions probably were favorable for the creation of life soon after the making of a solid crust of the earth. In a paper in preparation (*2*), the manner of occurrence of carbon in the early pre-Cambrian argillaceous sediments will be discussed, with special reference to the hypothesis of a reducing primordial atmosphere (*16*).

The validity, in principle, of using the isotopic constitution of carbon in rocks as an indicator of its biogenic or nonbiogenic origin has been questioned on isotope chemical grounds (*17, 18*). These arguments are answered in detail in another paper (*3*). It is sufficient to state in this note that geologic evidence must be considered very carefully when minerals and rocks are investigated and that arguments based solely on chemical evidence obtained in the laboratory may fail partly or totally. Of course, it is not always possible to decide whether the carbon in a rock is of biogenic or nonbiogenic origin. It is known that carbon in igneous rocks may lie in the biogenic range (*17, 19, 20*). In an igneous rock, this gives no proof of the derivation of carbon by biogenic contamination, unless, as in the instance of the Disko Island basalt (*20*), there exists conclusive geologic evidence indicating the origin. Predictions relative to expected isotopic fractionation by natural processes involving exchange equilibria should be based, among other things, on equilibria representing reactions that are probably operative, or at least approximated, in natural processes (*21*).

References and Notes

1. Kalervo Rankama. *Bull. Geol. Soc. Amer.* **59**, 389 (1948).
2. Kalervo Rankama. To be published in *Compt. rend. soc. géol. Finlande.*
3. Kalervo Rankama. *Geochim. et Cosmochim. Acta.* In press.
4. Thanks are due J. D. Allan, formerly of the Mines Branch, and G. H. Charlewood, of the Mines Branch, Winnipeg, for specimens and pertinent geologic information.
5. G. A. Russell. Preliminary Rept. 47–1, Manitoba Mines Branch (1948).
6. G. A. Russell. Preliminary Rept. and Map 48–3, Manitoba Mines Branch (1949).
7. J. F. Wright. *Can. Dep. Mines and Resources, Mines and Geol. Branch, Bur. Geol. and Topography, Mem. 169* (1932, reprinted 1938).
8. J. Tuzo Wilson. *Can. Mining Met. Bull.* **1949**, 231 (1949).
9. Arthur Holmes. *Trans. Edinburgh Geol. Soc.* **14**, 176 (1948).
10. L. H. Ahrens. *Nature* **160**, 874 (1947).
11. L. H. Ahrens, and Lorraine G. Gorfinkle. *Nature* **166**, 149 (1950).
12. H. C. Horwood, N. B. Keevil. *J. Geol.* **51**, 17 (1943).
13. Patrick M. Hurley. *Science* **110**, 49 (1949).
14. The $^{12}C/^{13}C$ ratios in Table 1 refer to the Stockholm carbon standard. Thanks are due Frans E. Wickman, of Stockholm, through whose courtesy the isotopic analyses were made.
15. C. B. Collins, R. D. Russell, and R. M. Farquhar. *Can. J. Phys.* **31**, 402 (1953).
16. Harold C. Urey. *Proc. Natl. Acad. Sci.* **38**, 351 (1952).
17. Harmon Craig. *Geochim. et Cosmochim. Acta* **3**, 52 (1953).
18. Harmon Craig. *Econ. Geol.* **48**, 600 (1953).
19. A. V. Trofimov. *Doklady Akad. Nauk S.S.S.R.* **85**, 169 (1952).
20. Viggo Münther, and W. Dansgaard. *Medd. Dansk Geol. Foren.* 12 (1951).
21. Earl Ingerson. *Bull. Geol. Soc. Amer.* **64**, 301 (1953).

Received February 4, 1954.

Maleic Hydrazide as a Sprout Inhibitor for Sweetpotatoes[1]

D. R. Paterson, G. W. Adriance, H. T. Blackhurst, and H. C. Mohr

Agricultural and Mechanical College of Texas, College Station

Maleic hydrazide has been used to inhibit sprouting in storage of onions, Irish potatoes, and carrots (*1–4*). There has been no report of the successful use of this chemical (*5*) to inhibit sprouting of sweetpotato roots.

Preliminary experiments by the writers with preharvest foliage applications of the 40 percent sodium salt of maleic hydrazide in a range of concentrations from 0 to 8000 ppm in the fall of 1952 indicated sprout inhibition of the bedded roots at the highest concentration, but the results were erratic.

On September 12, 1953, toothpicks impregnated with the 30 percent diethanolamine salt of maleic hydrazide in concentrations of from 0 to 100,000 ppm in ethyl alcohol were inserted halfway into sweetpotato roots (*2*). Three roots of each treatment were planted in vermiculite in metal flats. Sprouting was inhibited in the roots that received concentrations of 12,000 ppm or greater of the chemical.

In a subsequent experiment, October 9, 1953, 60 roots of the Texas Porto Rico variety of sweetpotatoes were divided into six equal lots and were similarly treated by inserting toothpicks impregnated with the 30 percent diethanolamine salt of maleic hydrazide in the concentrations shown in Table 1. The treated roots were bedded in a hot bed maintained at 80° F by an electric soil-heating cable and covered with 2 in. of sandy loam soil.

Table 1 shows the number of slips over 6 in. in length that were harvested from each root in each

TABLE 1. Sprout production of Texas Porto Rico sweetpotatoes subsequent to treatment with maletic hydrazide* impregnated toothpicks.

Treatments Maleic hydrazide concentrations (ppm)	Average number of sprouts per root			
	Length of sprout			
	Over 6 in.		Over 1 in.	Total
	11/16/53	11/24/53	12/14/53	
0	5.4	6.1	4.7	16.2
1,000	4.8	6.3	3.8	14.9
2,000	4.2	2.0	8.6	14.8
4,000	8.6	1.8	5.0	15.4
8,000	0.0	1.1	2.8	3.9
16,000	.0	1.6	1.9	3.5
	Difference necessary for significance between treatments			
			5% level	5.44
			1% level	7.21

* Formulated as the water soluble diethanolamine salt of 1,2-dihydro 3,6 pyridazinedione, and supplied by the U.S. Rubber Co., Naugatuck Division, Naugatuck, Conn.

[1] Technical Article No. 1903 of the Texas Agricultural Experiment Station.