k30 Geochronology by radiometric decay

< Great Lakes, pioneer studies >

> While this [geochronology] is the shining hope for ultimate subdivision of the Precambrian, it must not be thought that it requires merely more measurements, or even that ultimate success is assured.
>
> —Harold L. James, 1960.[1]

Pioneer efforts in geochronology by radiometric decay of ^{40}K to ^{40}Ar and ^{87}Rb to ^{87}Sr were made on the Precambrian formations in the Great Lakes region. At the time much attention was paid to the pegmatites that cut undeformed through the Precambrian complex rocks as being obviously the last manifestations of granite emplacement, or granitization, of these.

In the area of the Great Lakes prospection had discovered many ironformations (the first in 1865 in Lake Vermilion outcrops during the Vermilion Gold Rush) of (later) economic importance (iron mining was begun in the Mesabi range of Minnesota in 1882).[2] The question was how to relate the relatively simple homoclinal geology of the Animikie "group" in which these occurred, with the thicker, deeply folded, and many ironformation-layered Animikie "series" of Wisconsin and Michigan. Correlation of Animikean strata between the one area and the other had been questionably based on overall similarity and the occurrence of a profound nonconformity that separates the strata from an underlying granite and gneiss complex.

The initial results were perplexing (***Footnote k30.1***):

> In the Penokian fold belt, deformation was penetrative, involving together, the Animikie series and the nonconformity that separates them from the granite and gneiss complex.
>
> The Precambrian events, ordered in increasing age, using stratigraphic principles, are:
>
> Undeformed granite pegmatites that cut the folded Animikie series.
>
> The Penokian folding.
>
> Deposition of ironformation, limestone and sandstone on a deeply unroofed continental crust.
>
> Old Granite intrusion, or granitization, and concomitant metamorphism of metasedimentary and volcanic gneisses.
>
> In short, the Animikie series must be very much younger than the granite and gneiss complex.
>
> Radiometric dates obtained by careful and accurate methods found the reverse: radiometric ages are younger for granite-metasediment-metavolcanic basement and are older for the Animikie series.

Soon an understanding was reached. As Harold James, in 1960 reviewed: "The values obtained for the minerals from a metamorphic rock provide only the age of recrystallization, which may be far removed from the original age of the rock unit. In the second place, metamorphic and igneous rocks alike may be remetamorphosed, with varying degrees of response by individual minerals in the rocks, so that the age values obtained may be discordant or lacking in agreement with geologically determined relationships." [1] ❑

Footnote k30.1 [1] Disagreement of geologic chronology and radiometric dates obtained from micas in the rocks.

Geological succession of rock formations in the Felch trough of Marquette range, northern Michigan.

The Felch trough is a synclinorium of Anamikie ironformation, limestone and sandstone.

The Penokean orogeny is recorded by the foldings of the Animikie sediments along with the profound nonconformity that separates them from a complex of old granite and metasediment-metavolcic-gniess (Dickinson group).

The relative age of all is readily apparent in the field for:

Granite dikes that cut the Anamikie strata.

Granite pegmatites that do not cut the Anamikie strata, or the nonconformity, but do cut the Old granite and Meta seds & volcs.

So youngest to oldest formations are:

Granite dikes

Anamikie limestone, Anamikie sandstone

— PROFOUND NONCONFORMITY—

Granite pegmatite

Old granite

Meta seds & volcs

Geochronologic data (Aldrich & Wetherill,1960) for Marquette range, northern Michigan (Bi – biotite, Mu – muscovite, Mc – microcline).[3] Ages are in millions of years.

Granite dikes	Anamikie limestone	Anamikie sandstone		Granite pegmatite	Old granite	Meta seds & volcs
					Rb-Sr Bi 1130	
			P			K-Ar Bi 1280
			R			K-Ar Bi 1420
			O			Rb-Sr Bi 1420
			F			
	K-Ar Mu 1450		O			
	K-Ar Bi 1450		U			
			N			
K-Ar Bi 1570			D			Rb-Sr Bi 1570
Rb-Sr Bi 1600						
			N		Rb-Sr Mc 1600	
	Rb-Sr Bi 1620		O			
			N	K-Ar Mu 1630		
			C			
Rb-Sr Bi 1650			O			
Rb-Sr Mc 1650			N			
			F			
			O	K-Ar Mu 1690		
	Rb-Sr Mu 1700		R			
			M			
			I	Rb-Sr Mu 1720		
			T			
		Rb-Sr Mu 1980	Y			

The disagreement between the geologic history read from the rock record in the field and the K-Ar and Rb-Sr radiometric ages determined in the laboratory required explanation. Also, significant differences exist for ages obtained by different methods and from different minerals in a rock.