

Rb-Sr isotope evidence on the age of the Nagssugtoqidian orogeny in West Greenland, with remarks on the use of the term 'Nagssugtoqidian'

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According to the original definition, the Nagssugtoqidian orogeny took place after the intrusion of the Kangâmiut dykes in West Greenland (Ramberg, 1948). Two of these dykes have been dated recently and gave a Rb-Sr whole-rock isochron age of 1950 ± 60 m.y.* (Kalsbeek *et al.*, 1978). On the basis of petrographic and (isotope-) chemical criteria it was argued that this age dates the intrusion of the dykes and not a much later metamorphism, and this conclusion is supported by other lines of evidence (see Kalsbeek *et al.*, 1978). A lower age limit for the Nagssugtoqidian metamorphism is given by K-Ar biotite ages in the range of 1600–1800 m.y. (e.g. Larsen & Møller, 1968). The post-dyke Nagssugtoqidian metamorphism thus took place between c. 2000 and c. 1800 m.y., perhaps continuing to c. 1600 m.y.

Newer Rb-Sr whole-rock investigations in the Umanak–Upernavik region also indicate regional metamorphism at some time between 2000 and 1750 m.y. Metapelitic supracrustal rocks of the Marmorilik Formation (Umanak district) that overlies the basement with a well-preserved unconformity (Garde & Pulvertaft, 1976), gave an eight-point isochron suggesting an age of 1785 ± 25 m.y. for the metamorphism of the rocks. The Prøven granite-charnockite (Upernavik district) has given an age of 1865 ± 25 m.y. This granite cuts already metamorphic supracrustals (correlating with supracrustal rocks in the Umanak region) but has a faint metamorphic fabric itself, and thus probably intruded during the waning stages of the metamorphism. Assuming broad contemporaneity of the metamorphism in the Rinkian complex and the Nagssugtoqidian mobile belt to the south, the age of the main Nagssugtoqidian metamorphism seems thus reasonably well established.

The age of the pre-dyke shear zones, now commonly referred to as Nag. 1, is as yet more elusive. Rb-Sr analysis, several years ago, of a number of scattered samples of Nagssugtoqidian gneisses, gave a poor isochron, suggesting an age of 2640 m.y. (2700 m.y. using $\lambda^{87}\text{Rb} = 1.39 \times 10^{-11}/\text{y}$). The interpretation of this age, however, is not quite clear. The Nagssugtoqidian gneisses studied, among which there were several samples from shear zones in the Archaean basement, are distinctly richer in Rb than the Archaean gneisses from which they presumably formed, and it is possibly that the 2640 m.y. age dates a Rb metasomatism affecting the rocks during the Nag. 1 shear zone formation (Kalsbeek & Zeck, 1978). If this is so then also the Nagssugtoqidian gneisses that are not obviously affected by Nag. 1 must

* All ages calculated using $\lambda^{87}\text{Rb} = 1.42 \times 10^{-11}/\text{y}$. Uncertainties are at the 2σ level.

have undergone this metasomatism at the same time, since they plot on the same line as samples from the shear zones (Kalsbeek & Zeck, 1978).

This last suggestion is supported by the study of samples from a large banded gneiss block from a quarry near Søndre Strømfjord airbase. Since this is what one might call the 'type locality' of Nag. 2 thrusting and metamorphism, it was assumed that Rb-Sr analyses would give an impression of the age of the Nag. 2 metamorphism. Although petrographic and chemical evidence clearly indicate mobility of K, Rb and probably Sr, during the metamorphism, no good isochron was obtained. The rocks roughly plot along a 2600 m.y. line in an isochron diagram. Four adjoining samples plot within analytical precision on this line and define an age of 2590 ± 100 m.y. This indicates that the strong shearing and metamorphism of the rocks dated did not take place during Nag. 2. Preliminary mineral ages from one sample suggest mineral resetting at approx. 1500 m.y.

The results outlined above may be summarised as follows:

(1) The Nagssugtoqidian orogeny as defined by Ramberg took place between *c.* 2000 and *c.* 1800 m.y.

(2) Evidence described in this paper and in other contributions to this symposium suggests that several Nag. 1 (?) shear zones may have formed at *c.* 2600 m.y., but as yet no cases of perfect resetting of the Rb-Sr systems during this event have been reported.

(3) There is evidence that in the Søndre Strømfjord area the 2600 m.y. event had a much more profound influence on the Rb-Sr whole-rock systems than Nag. 2.

When it was first observed that undeformed and unmetamorphosed Kangâmiut dykes had intruded into earlier shear zones, it was thought that 'The intrusion of the Kangâmiut dyke swarm took place during, or just after the first Nagssugtoqidian ENE shear movements' (Bridgwater *et al.*, 1973, p. 23). It was therefore natural to use the term Nag. 1 for the tectonic phase that gave rise to these shear zones. Now that it becomes clear that in fact there may be a difference in time of some 600 m.y. between the formation of the shear zones and the intrusion of the dykes into them, it seems equally natural to abandon the term 'Nag. 1' for what now appears to be a late Archaean phase of shear zone formation. An important reason for doing so would be that the Nagssugtoqidian as defined by Ramberg gives a straight-forward correlation with the Hudsonian in Canada and the Laxfordian in Scotland. Incorporating Late Archaean events in the Nagssugtoqidian unnecessarily complicates the picture.

On the other hand, using the term 'Nagssugtoqidian' in the sense of Ramberg, the terms 'Nagssugtoqidian orogenic complex' as used on the Tectonic/Geological map of Greenland (Escher, 1970), or 'Nagssugtoqidian mobile belt' as used in numerous publications, becomes difficult to administrate. I may well prove that several of the shear zones that characterise the 'Nagssugtoqidian mobile belt' are not Nagssugtoqidian but late Archaean in age. Only careful mapping combined with isotopic age work can then show how much of the belt is really Nagssugtoqidian.

Perhaps the term 'Pre-Nagssugtoqidian shear zones' could be used to replace the term Nag. 1. This would clearly indicate that they are older than the Nagssugtoqidian in the Rambergian sense, but retain the suggestion of a causal relationship with it.

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