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THE MUGFORD GROUP, NORTHERN LABRADOR, REVISITED: NOTES FROM A CONTINUING STUDY[1]

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ABSTRACT

Field examination of the Mugford Group in 1993 and laboratory analyses of samples collected in 1992 have revealed a number of new details about the Mugford Group. These include: (i) the presence of coccoidal and filamentous fossils in chert, (ii) mapping of a folded diabasic dyke, (iii) examination of a uraniferous chert occurrence, (iv) definition of PGE contents in an ultramafic sill, (v) presence of authigenic titanite, (vi) mapping of massive pyrrhotite near Lost Channel, and (vii) re-definition of a previously described fold as a thrust fault.

INTRODUCTION

The Mugford (Coleman, 1921), or Kaumajet Mountain (Daly, 1902) Group is a little deformed ca. 2000 Ma supracrustal sequence deposited on the Archean Nain craton (Taylor, 1971) in northern Labrador (Figure 1). The unit consists of a lower, 155-m-thick, sedimentary sequence (the Sunday Run and Cod Island formations) and an upper, 1070-m-thick, mainly volcanic sequence (Smyth, 1976; Smyth and Knight, 1978). Wilton *et al.* (1993) reported on a metallogenic examination of the lower sedimentary horizons. Since that paper was published, subsequent laboratory analyses and field work in 1993 have generated some new results that are reported here.

RESULTS

MICROFOSSILS

Wilton *et al.* (1993) reported the presence of coal seams within the Cod Island Formation. Due to the Early Proterozoic age of the Mugford Group, the coal could not have been derived from higher plants and must have been algal or bacterial in origin. Therefore, the material should be classified as a sapropelic boghead coal (after Stach *et al.*, 1975).

Microstructures that appear to be coccoidal (Plate 1) and filamentous microfossils were discovered during petrographic examination of chert sections. These microfossils resemble those found in the Early Proterozoic Gunflint Chert of Ontario (Strother and Tobin, 1987) and Duck Creek Dolomite of Australia (Knoll *et al.*, 1988). Gramly (1978) described fine carbon layers during petrographic examination of Mugford Group chert that he thought were possible fossil algal colonies.

The Mugford Group examples are the first fossils reported from the Nain craton. Further work is in progress to identify and classify these microbiota.

DEFORMED DYKE

On the cliff face at the northwest end of Mugford Tickle, a 2-m-wide folded, north–south-trending, diabasic dyke cuts the debris flow unit of the Cod Island Formation (Wilton *et al.*, 1993). The dyke is a grey-weathering fine-grained rock with numerous small (≤ 2 mm long) plagioclase crystals. The fold is a west-verging, moderately inclined S-fold (Plate 2). Smyth (1976) noted that a steep axial-planar cleavage was developed in association with folding of sedimentary units, but this is the first report of folded dykes within the Mugford Group. Wilton *et al.* (1993) reported small-scale recumbent folds in the Cod Island Formation shales at Green Cove, but the dyke fold is steeper.

Smyth (1976) reported north-northeast-trending diabase dykes cutting the Mugford Group. Hamilton (1993) described grey-weathering diabase dykes cutting the Mugford Group that, based on his descriptions, are the same as this folded dyke. Hamilton (*op cit.*) suggested that these dykes were Middle(?) Proterozoic in age based on similar orientations

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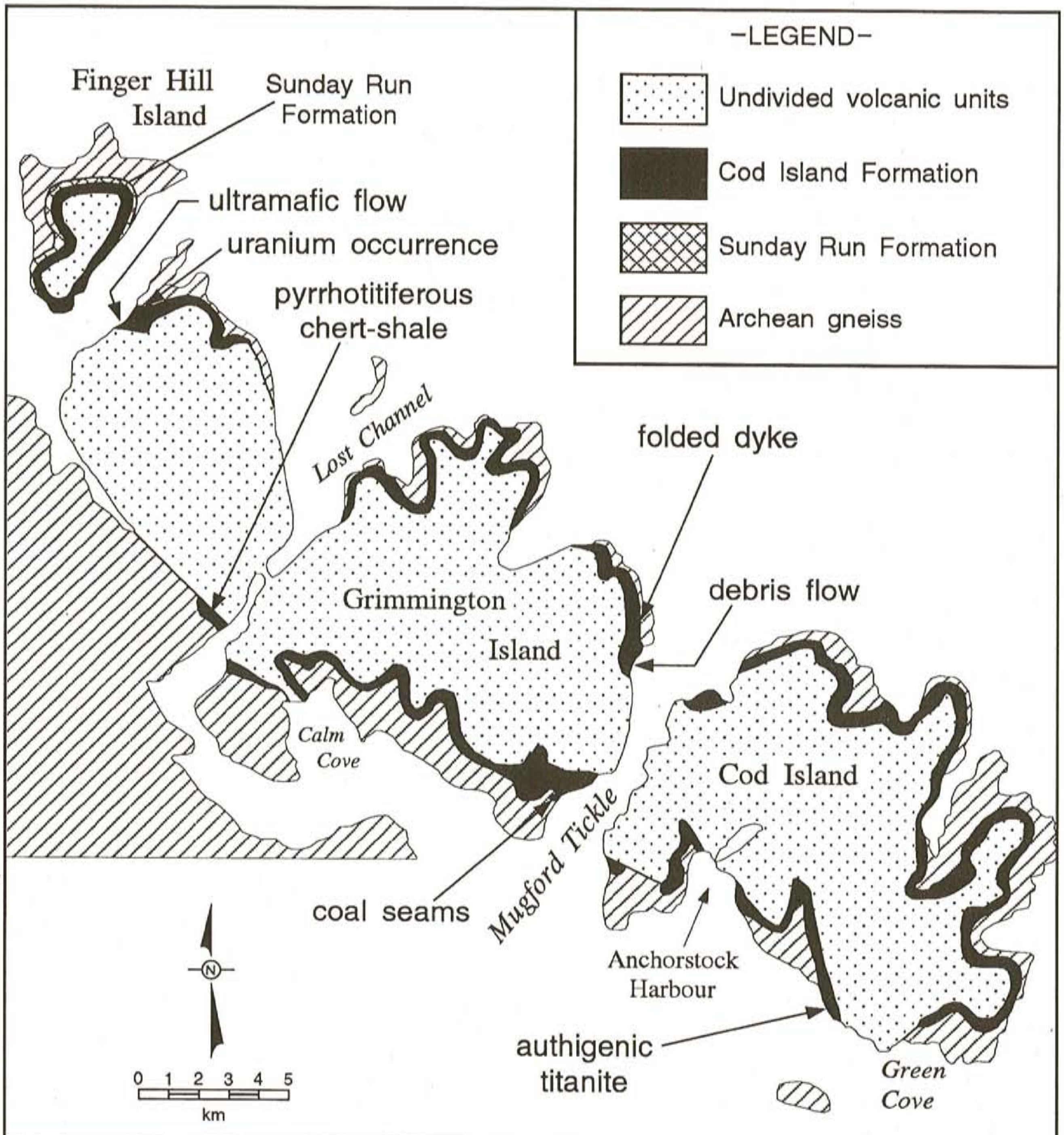


Figure 1. *Geological map of the Mugford Group with locations as described in the text (after Smyth, 1976).*

to Ermanovics *et al.*'s (1989) Nutak dyke swarm. According to Ermanovics *et al. (op cit.)*, however, the Nutak dykes are undeformed, gabbroic, olivine-titanoaugite-bearing rocks of post-Elsonian (ca. 1450 Ma) age.

Based on the fold in one of these dykes, the swarm presumably formed before deformation associated with the Torngat Orogen. Bertrand *et al.* (1990) derived U–Pb monazite data that suggest greenschist- to granulite-facies metamorphism of the Mugford Group in the Torngat Orogen occurred ca. 1805 to 1786 Ma. These grey dykes, therefore, cannot be Nutak, unless there was a later, as yet undefined, deformational episode, post-1450 Ma. Further detailed geochemical work is being carried out on this dyke to further define its origin.

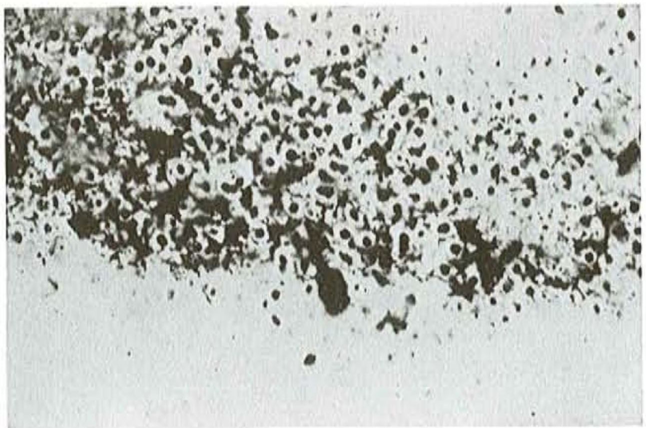


Plate 1. *Photomicrograph of coccoidal microfossils from a chert horizon (view is 0.5 mm across).*

Plate 2. *Folded grey-weathering dyke (centre of plate) cutting Cod Island Formation rocks, Mugford Tickle.*

URANIFEROUS SHOWING

Smyth (1976) discovered a 6-m-long by 1-m-wide radioactive showing (12 x background) in the basal Sunday Run Formation hosted by what he termed black shales and interbedded black sandstones.

Blackwell (1976) examined the occurrence, describing it as a black carbonaceous, pyrite-bearing, radioactive chert sandwiched between two small conglomerate lenses. A grab sample from a 0.2 by 2.5 m area contained 620 ppm U, whereas another sample from elsewhere in the outcrop contained only 0.1 ppm U (Blackwell, *op cit.*). On the basis of these geochemical data, Blackwell (*op. cit.*) dismissed the economic potential due to the very small size of the occurrence.

The showing, re-examined in 1993, occurs at the top of a small ridge on the southeast side of Sunday Run (Figure 1) within a 25-cm-thick, massive black chert of the Sunday Run Formation (Plate 3). The chert is interbedded with quartz pebble conglomerate and sandstone immediately above the Archean basement. As described by Blackwell (1976), the area of enhanced radioactivity is quite small. Pyrite was not visible

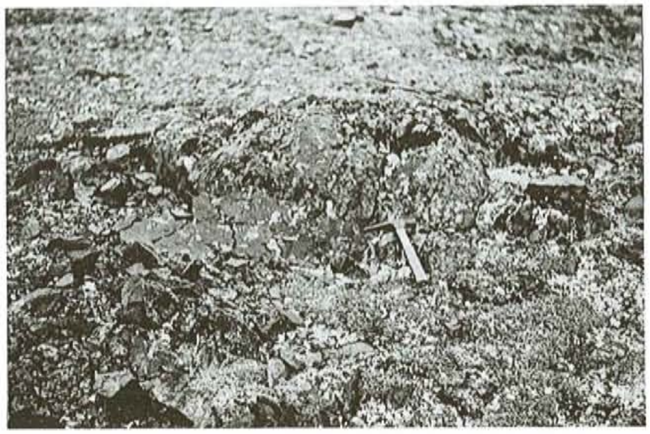


Plate 3. *Radioactive chert occurrence in Sunday Run Formation, Sunday Run. The chert horizon extends to the left from hammer and is overlain by quartz-pebble conglomerate.*

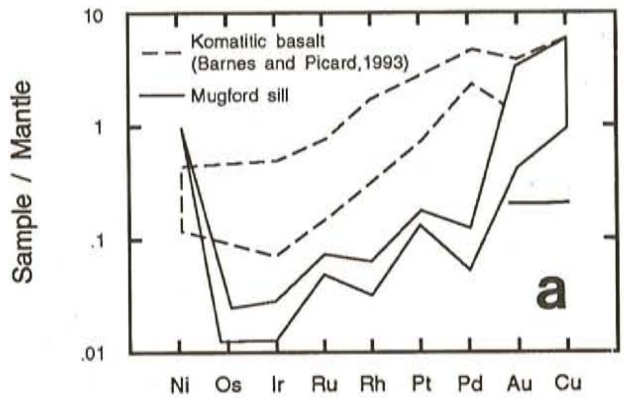
in hand specimen. No uranium alteration minerals coat weathered surfaces and, therefore, the uranium is tightly bound within the massive chert.

Although of little obvious economic value, the occurrence is intriguing due to the age and depositional environment of the host rocks. The high energy, quartz-pebble conglomerates that encompass the chert, are superficially, at least, similar to Precambrian quartz-pebble conglomerates that contain detrital uraninite at Elliot Lake and the Witwatersrand (e.g., Armstrong, 1981). It has been suggested that detrital uraninite could only be deposited early in Earth history, pre-1.9 Ga, when there were low to nil O_2 contents in the atmosphere. Holland and Beukes (1990) suggested that atmospheric oxygen increased dramatically between 2.2 and 1.9 Ga. The Mugford Group was apparently deposited around the time of this supposed change in the atmospheric environment. Detailed study of the textural nature and mineralogical form of the uranium minerals from the Sunday Run occurrence, therefore, may add some significant details to the understanding of uranium metallogenesis in the Lower Proterozoic rocks of northern Labrador.

ULTRAMAFIC SILL

Wilton *et al.* (1993) reported the presence of a 17-m-thick layered mafic–ultramafic sequence on the southwest side of Sunday Run of uncertain flow or sill origin. Re-examination of the unit in 1993, suggests that the unit is indeed a sill, but one that intruded into unconsolidated sediments. This supposition was based on the presence of irregularly shaped sedimentary fragments with reaction rims within the base of the sill and columnar jointing in grey silicious siltstone below the sill. It must be noted, however, that the top of the sill is unexposed and, hence, a possible chilled rim was not observable.

Platinum-Group-Element (PGE) analyses have been carried out on three samples from within this sill. In terms of mantle-normalized patterns (Figure 2a), this sill is highly



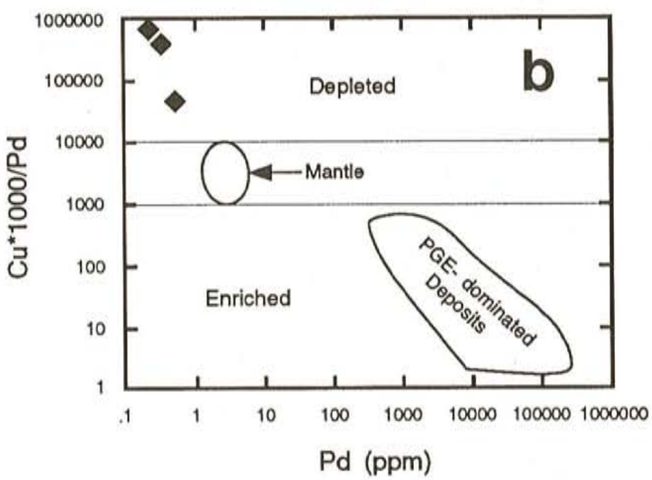


Figure 2. *a) Mantle-normalized PGE patterns for samples from the ultramafic sill on the southwest side of Sunday Run and average komatiitic basalt (Barnes and Picard, 1993); normalization factors from Barnes* et al. *(1988); b) Cu-Pd variation diagram for samples of Mugford Group ultramafic sill (solid diamonds); fields from Barnes* et al. *(1993).*

depleted in PGE compared to average komatiitic basalt, even though Ni, Au and Cu contents are similar. As further illustrated on Figure 2b (after Barnes *et al.*, 1993), the samples are more depleted in PGE than typical mantle. These comparisons suggest that PGEs were effectively removed from the ultramafic magmas by a sulphide phase. If the sulphide phase was derived from assimilation of sulphide-bearing sedimentary sequences in the Mugford Group, then the potential exists for economically interesting PGE mineralization in the vicinity of the lower portions of the sill. In fact, chalcopyrite–pyrrhotite blebs within the bottom breccia zone of the sill have been reported by Smyth (1976) and Wilton *et al.* (1993); further analyses are being carried out on these sulphide samples to ascertain their PGE contents.

AUTHIGENIC TITANITE

A sulphide-bearing, green chert horizon within the Cod Island Formation contains euhedral, apparently authigenic, titanite crystals (Plates 4a and b). These crystals are up to

A

B

Plate 4. *a) Photomicrograph of euhedral titanite crystals (dark, diamond-shaped crystals) in green cherty rock, Anchorstock Harbour (view is 2 mm across); b) Scanning electron photomicrograph of titanite crystals as in Plate 4a. Scale bar (line of dots across base) is 40 um.*

0.075 mm across. Authigenic titanite is not common but has been reported by Yau *et al.* (1987) from the Salton Sea geothermal field, where the titanite formed through hydrothermal metamorphism of argillaceous sediments. In the Mugford Group case, the complete package of lower sedimentary rocks are overlain by very extensive marine volcanic rocks and the chert itself is <10 m below the volcanic rocks. Hence, the titanite in the chert may have formed via hydrothermal metamorphism by the overlying volcanic pile. Alternatively, the titanite may have formed from lower greenschist-facies metamorphism.

The Mugford Group has proven quite difficult to date by high-precision U−Pb techniques. These titanites are being further investigated as a possible mineral separate to be analyzed by such techniques.

SULPHIDE-BEARING CHERT (LOST CHANNEL)

Wilton *et al.* (1993) reported the presence of pyritic and pyrrhotitic 'massive sulphide' horizons interbedded with chert and shale−siltstone along the southern portions of Cod Island (Anchorstock Harbour) and in the debris flow along the west side of Mugford Tickle. During 1993, pyrrhotitic massive sulphide layers interbedded with black chert and shale were found in the bed of a small stream flowing into the Lost Channel.

THRUST FAULT

Wilton *et al.* (1993) suggested that a large, east-facing recumbent fold was exposed in a cliff face near the debris flow along Mugford Tickle. Re-examination of this exposure in 1993 with much better weather, revealed that the fold is actually a thrust fault.

CONCLUSIONS

The Mugford Group has a rather limited areal extent. Because of the relatively undeformed and unmetamorphosed nature of this group, coupled with its apparent deposition during one of the more critical periods of Earth history, the unit has excellent potential to provide answers to some profound geological questions. It is certainly a sequence that deserves intense investigation.

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REFERENCES

Armstrong, F.C.
1981: Genesis of uranium- and gold-bearing Precambrian quartz pebble conglomerates. United States Geological Survey, Professional Paper 1161-A-BB.

Barnes, S-J., Boyd, R., Korneliussen, A., Nilsson, L-P., Often, M., Pederson, R-B. and Robins, B.
1988: The use of mantle normalization and metal ratios in discriminating between the effects of partial melting, crystal fractionation and sulphdie segregation on platinum-group-elements, gold, nickel, and copper: Examples from Norway. *In* Geo-platinum 87. *Edited by* H.M. Prichard. Elsevier, pages 113-143.

Barnes, S-J., Couture, J-F., Swayer, E.W. and Bouchaib, C.
1993: Nickel-copper occurrences in the Belleterre-Angliers Belt of the Pontiac Subprovince and the use of Cu-Pd ratios in interpreting platinum-group element distributions. Economic Geology, Volume 88, pages 1402-1418.

Barnes, S-J. and Picard, C.P.
1993: The behaviour of platinum-group-elements during partial melting, crystal fractionation, and sulphide segregation: An example from the Cape Smith Fold belt, northern Quebec. Geochimica et Cosmochimica Acta, Volume 57, pages 79-87.

Bertrand, J-M., van Kranendonk, M., Hanmer, S., Roddick, J.C. and Ermanovics, I.
1990: Structural and metamorphic geochronology of the Torngat Orogen in the North River−Nutak transect area, Labrador: Preliminary results of U−Pb dating. Geoscience Canada, Volume 17, pages 297-300.

Blackwell, J.D.
1976: Ramah reconnaissance. Cominco Limited, Unpublished Report, 20 pages.

Coleman, A.P.
1921: Northeastern part of Labrador, and New Quebec. Geological Survey of Canada, Memoir 124, 68 pages.

Daly, R.A.
1902: The geology of the northeast coast of Labrador. Bulletin of Com. Zoo., Harvard, Volume 38, Geology Series, Volume 5, No. 5.

Ermanovics, I.F., van Kranendonk, M., Corriveau, L., Mengal, F., Bridgwater, D. and Sherlocks, R.
1989: The boundary zone of the Nain-Churchill provinces in the North River−Nutak map areas, Labrador. *In* Current Research, Part C. Geological Survey of Canada, Paper 89-1C, pages 385-394.

Gramly, R.M.
1978: Lithic source areas in northern Labrador. Arctic Anthropology, Volume XV, pages 36-47.

Hamilton, M.A.
1993: Preliminary report on the geology of the Mugford Group volcanics, northern coastal Labrador. *In* Current Research, Part C. Geological Survey of Canada, Paper 93-1C, pages 349-357.

Holland, H.D. and Beukes, N.J.
1990: A paleoweathering profile from Griqualand West, South Africa: Evidence for a dramatic rise in atmospheric oxygen between 2.2 and 1.9 BYBP. American Journal of Science, Volume 290-A, pages 1-34.

Knoll, A.H., Strother, P.K. and Rossi, S.
1988: Distribution anbd diagenesis of microfossils from the Lower Proteroozoic Duck Creek Dolomite, Western Australia. Precambrian Research, Volume 38, pages 257-279.

Smyth, W.R.
1976: Geology of the Mugford Group, northern Labrador. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 76-1, pages 72-79.

Smyth, W.R. and Knight, I.
1978: Correlation of the Aphebian supracrustal sequences, Nain Province, northern Labrador. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 78-1, pages 59-64.

Stach, E., Mackowsky, M.-Th., Teicmuller, M., Taylor, G.H., Chandra, D. and Teichmuller, R.
1975: Coal Petrology. Gebruder Borntaeger, Berlin, 428 pages.

Strother, P.K. and Tobin, K.
1987: Observations on the genus Huroniospora Barghoorn: Implications for paleoecology of the Gunflint microbiota. Precambrian Research, Volume 36, pages 323-333.

Taylor, F.C.
1971: A revision of Precambrian structural provinces in northeastern Quebec and northern Labrador. Canadian Journal of Earth Sciences, Volume 8, pages 579-584.

Wilton, D.H.C., Churchill, R.A. and Saunders, G.K.
1993: Stratigraphy and metallogeny of the Cod Island and Calm Cove formations, Mugford Group, northern Labrador. *In* Current Research. Newfoundland Department of Mines and Energy, Geological Survey Branch, Report 93-1, pages 91-102.

Yau, Y.C., Peacor, D.R. and Essene, E.J.
1987: Authigenic anatase and titanite in shales from the Salton Sea Geothermal field, California. Neues Jahrbuch Mineralogie, Volume 10, pages 441-452.