# The Dictyonema-bearing phyllites at Nordaunevoll, eastern Trøndelag, Norway

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The Dictyonema-bearing black phyllites of Nordaunevoll are intimately related to pillow basalts and intruded by a dolerite dyke-swarm. Their trace element chemistry (up to 1700 ppm V, 150 ppm Mo, and 100 ppm U) and high contents of organic material are similar to alum shales of the same age, deposited on the Baltoscandian Platform in central and southern Sweden. This black phyllite formation represents an important stratigraphic marker in the Caledonian allochthon of eastern Trøndelag which may prove to be of regional significance both in Norway and Sweden.

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Nordaunevoll is one of the key localities for the understanding of Trøndelag geology. Ever since the discovery of Tremadocian graptolites (J. H. L. Vogt 1889), identified as *Dictyonema flabelliforme sociale* by Størmer (1941), the prime importance of the Nordaunevoll relationships has been recognized. The occurrence of the graptolites places constraints on both the age of the eastern Trøndelag stratigraphy and the timing of deformation and bears directly on the interpretation of the local and regional tectonics. Only one other fossil-bearing unit is known in eastern Trøndelag, also in black phyllites, the Llandoverian graptolite-bearing (Getz 1890) Slagån Group on Kjølhaugan (Siedlecka 1967, Hardenby 1980).

The Nordaunevoll fossiliferous phyllites occur (Th. Vogt 1941) in the western part of a steeply-dipping, north-striking succession of volcanic rocks correlated with the Fundsjö Group of eastern Trøndelag. These volcanic units are in contact to the west with pelites included in the Gula Complex (previously Group). Wolff (1967, 1979), Nilsen (1971) and Rui (1972) regarded the Nordaunevoll phyllites to be part of the Gula Group, infolded into the Fundsjö Group. Nilsen (1971) demonstrated that the black phyllites were interlayered with the volcanic rocks. Wolff (1973) included them in the Fundsjø Group. New investigations have shown that the phyllites are intimately related to pillow lavas and that they are intruded by a swarm of dolerites. That the volcanicity was contemporaneous with the deposition of the black shales is probable. However, detailed remapping is required to eliminate the possibility that the relationships are the result of tectonic intercalation.

The preservation of the fossils is probably due to their location within the andalusite zone of the contact aureole of the Hyllingen gabbro (Nilsen 1973, Wilson & Olesen 1975). Elsewhere, the phyllites occur at higher grade (with sillimanite) within the aureole and also outside the influence of the intrusion where the penetrative deformation is more intense.

Trace element (V, Mo, U) analysis of the Nordaunevoll phyllites has demonstrated a chemistry that is strikingly similar to that of sediments of similar type and age on the Baltoscandian Platform in Skåne and Östergötland. Vanadium ranges from c.700 to 1700 ppm, Uranium from c.25 to 100 ppm and Molybdenum from c.60 to 150 ppm. That these highly organic-rich phyllites are radioactive was recognized during prospecting for uranium in the nineteen-fifties (Th. Siggerud, pers.comm. 1980). Our field investigations west and south of the Hyllingen gabbro massif lend support to the suggestion of N. Spjeldnæs (unpublished report 1974) that, with the help of a gamma scintillometer, it may be possible to map this formation over considerable distances in eastern Trøndelag. It may even prove possible to identify similar tectono-stratigraphic levels in the Swedish Caledonides of northern Jämtland and Västerbotten, and elsewhere in the mountain belt. Highly graphitic phyllites and schists have been reported from a number of eastern Trøndelag localities in the Gudå Formation (or Group) separating the Gula from the Fundsjø units and

a Swanson (1961, p.70) gives average black shale U=8 ppm and "shallow" marine black shales U=20 ppm.

Table 1. Comparison of the contents of trace elements (Mo, U, V) and organic matter in the Nordaunevoll black phyllites with contents of these elements in average and other black shales. Trace elements analysed by XRF methods with accuracy of ± 10 %. Background gamma-radiation = 10 u R/h; average black shale 10-20 u R/h. Skåne data from Boliden Metal AB.

| Specimen No. | Location | Gamma-radiation in-field-u R/h | Corg(%) | Mo(ppm) | U(ppm) | V(ppm) |
|---|---|---|---|---|---|---|
| Average shale - (Turekian & Wedepohl 1960) | | - | - | 3 | 4 | 130 |
| Average black shale (Vine & Tourtelot 1970) | | - | 3.2 | 10 | a | 150 |
| Top-black unit of Gassaway Member of Chatanooga Shale (O'Niel 1956) | | - | 12.5 ($C_{tot}$%) | 400 | 87 | 800 |
| Upper Cambrian alum shale at Ranstad (Armands 1972) | | - | 13.7 | 270 | 206 | 680 |
| Skåne, (Tosterup) Dictyonema sh | | - | 8-8.5 | 80-90 | 60 | 1600-3600 |
| DG 79:9 | Nordaunevoll | c 80 | 18.2 | 83 | 34 | 1708 |
| :10 | -"- | c 60 | 8.4 | 68 | 26 | 729 |
| :11 | -"- | c 100 | 19.5 | 144 | 103 | 1019 |
| :12 | -"- | c 50 | 5.8 | 97 | 52 | 789 |

lying approximately at the same tectonostratigraphic level as the Nordaunevoll formation.

This note focuses attention on the importance of studies of trace element geochemistry in shales (particularly black shales). In areas such as the Scandinavian Caledonides, where Baltoscandian Cambrian to Tremadoc black shales have a clear geochemical signature, they may play an important role in the identification and correlation of stratigraphy (cf. Gee 1980) and hence a decisive role in the tectonic interpretation.

Another aspect of interest in relation to this *Dictyonema* occurrence in uraniferous, vanadiniferous, highly-organic meta-argillites, relates to the question of faunal provinciality. It is commonly accepted that *Dictyonema flabelliforme* is a species characteristic of the Atlantic (or European) faunal province (Bulman 1971). Both trace element geochemistry and faunal provinciality favour deposition of the Nordaunevoll formation on the eastern side of the Iapetus Ocean in the latest Cambrian to earliest Ordovician, a line of evidence so important that it warrants further assessment.

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