CHAPTER 2

STRATIGRAPHY

2.1 Older Sandstone Series

The aims in considering the Older Sandstone Series are: 1) to determine the approximate shape of the unconformity with the overlying Vestertana Group, and 2) to aid in the identification of the source of material in the Smalfjord Tillite.

Except for the Grasdalen Formation at the top, the Older Sandstone Series consists of sandstone and shale formations (fig. 4). The Fugleberget to the base of the Grønnes Formation are fluvial deposits, while the Veinesbugten and Klubnes Formations, and the units from the upper part of the Grønnes Formation to the Grasdalen Formation are thought to be marine (Banks et al. 1971).

Recent work has shown the lateral continuity and relative uniformity of the Grønnes to Grasdalen Formations between Varangerfjord and Tanafjord (Røe, 1970), and of the Dakkovarre to Hanglecerro Formations over to Laksefjord (Edwards et al. in preparation). Although Røe does not conclude which of the two conglomerate horizons (units V and VI) in the Varangerfjord section correlate with the base of the Grønnes Formation in Tanafjord, the present author has taken the high conglomerate as the equivalent to the Grønnes (Table 2). Further work remains to be done on this stratigraphic problem.

To determine the shape of the unconformity two assumptions must be made: 1) the formations are of consistent thickness over the area concerned, and 2) the base of the Older Sandstone Series in Varangerfjord, the Veinesbugten Formation, can be taken as a datum from which to measure the thickness of Older Sandstone Series preserved beneath the unconformity. The first assumption is supported by the regional correlation cited above. Formational thickness changes between Tanafjord and Varangerfjord are on the order of about 15%, and probably less between Tanafjord and Laksefjord. It is impossible to test the second assumption at

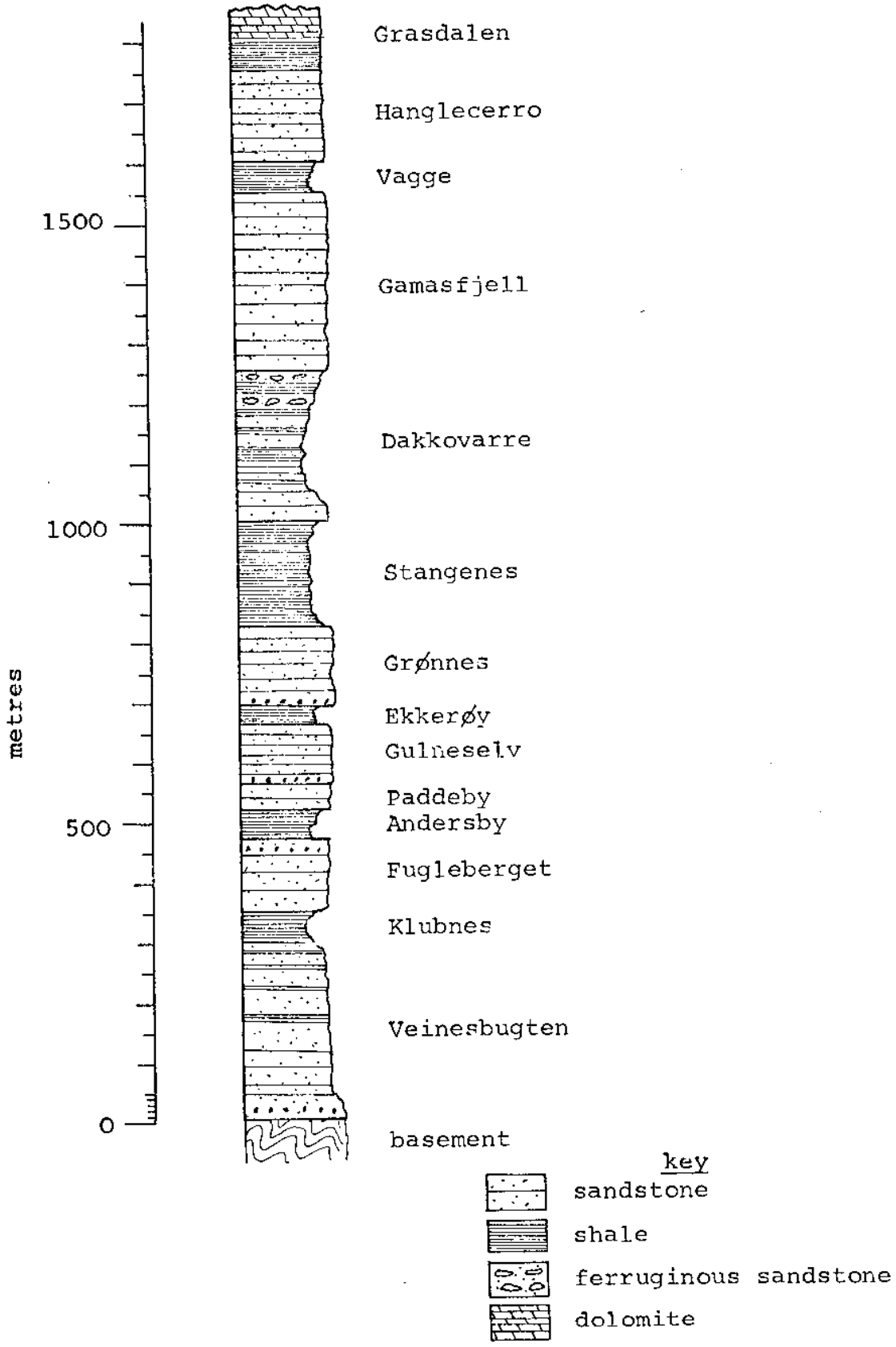

Figure 4, Composite section through the Older Sandstone Series, based on one of the correlations between Tanafjord and Varangerfjord suggested by Røe, 1970. (see text)

cumulative thickness	Tanafjord		Tanafjord and Varangerfjord		Varangerfjord			cumulative thickness (metres)
	Siedlecka and Siedlecki, 1971		Røe, 1970		Hobday and Taylor, in prep.		Banks et al., 1971	
2040								
	100	Grasdal						
1940								
	150	Hanglecerro		XII				
1790								
	80	Vagge	50	XI				
1710								
	280	Gamasfjell	300	X				
1430								
	350	Dakkovarre	250	IX VIII				
1080								
	255	Stangenes	180	VII				
825								
	130	Grønnes	130	VI			Upper Sandstone	
695								695
			30	V	35	Ekkerøy	Upper Siltstone	
			100					660
					100	Gulneselv	Middle Sandstone	
			40	IV	40	Paddeby		
								520
			50	III	50	Andersby	Middle Siltstone	
								470
			112	II	120	Fugleberget	Lower Sandstone	
								350
				I	50	Klubnes	Lower Siltstone	
								300
					300	Veinesbugten		

Table 2. Lithostratigraphy of the Older Sandstone Series (Tanafjord Group) of Tanafjord and Varangerfjord.

this time, as there is no information on the lower part of the Older Sandstone Series north of Varangerfjord.

The variation in thickness of the Older Sandstone Series (fig. 5) shows erosion to the SSW on the Varanger Peninsula, and to the SE, south of Laksefjord. The average slope for this unconformity between Trollfjord and Varangerfjord is $1^{\circ}53'$. Between Trollfjord and SW of Leirpollen the slope is 46', and for 7 km north of Varangerfjord is $3^{\circ}17'$, all slopes determined in a direction just east of north. These values are similar to the $1\text{-}2^{\circ}$ estimated by Føyn (1937, p.75). On the Varanger Peninsula the slope thus appears to increase to the south. A similar trend is not apparent south of Laksefjord where the slope is quite steep locally.

Two lithologies in the Older Sandstone Series are distinctive enough to be readily identified as clasts in the Smalfjord Tillite. The most important is the dolomite and chert (silicified dolomite) in the Grasdalen Formation, which may compose almost 100% of the clasts in parts of the tillite. The second lithology is the ferruginous sandstone, ferruginous nodules, and siderite-cemented sandstones from the ferruginous sandstone member of the upper part of the Dakkovarre Formation (Siedlecka and Siedlecki, 1971). This member occurs both at Tanafjord and Laksefjord, but the only sign of ferruginous material at Varangerfjord are the dark spots on the sandstone, and a rusty-red colouration (Røe, 1970).

No units higher than the Grasdalen Formation are known from the Older Sandstone Series, or from the equivalent at Porsangerfjord, the upper part of the Børselv Sub-Group (Gayer and Roberts, 1971).

2.2 Smalfjord Tillite Formation

The Smalfjord Tillite (Bjørlykke et al. 1967) outcrops in two widely separated areas: Varangerfjord in the southeast, and Tanafjord and Laksefjord in the north and west respectively. In the Varangerfjord area the formation has recently been described

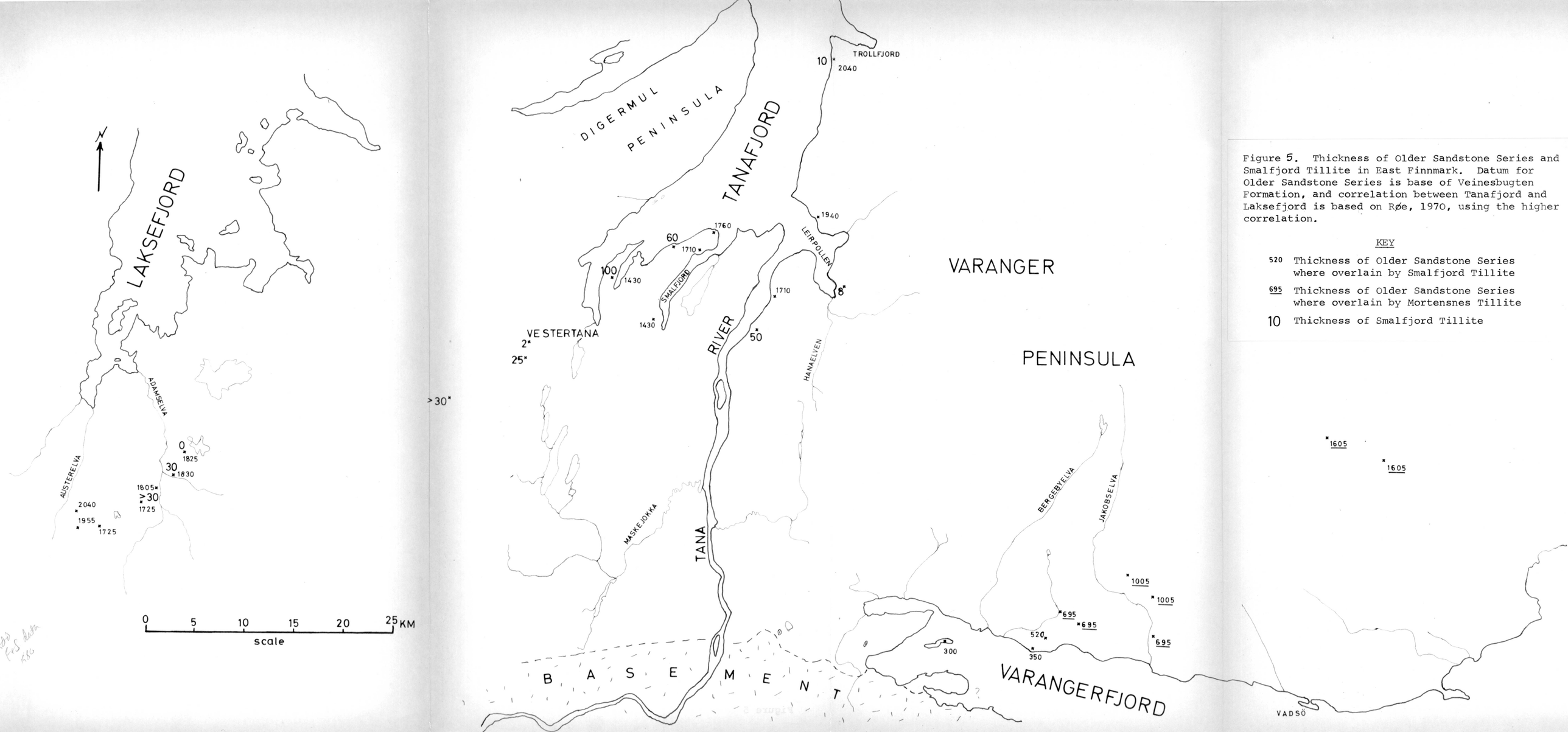

Figure 5. Thickness of Older Sandstone Series and Smalfjord Tillite in East Finnmark. Datum for Older Sandstone Series is base of Veinesbugten Formation, and correlation between Tanafjord and Laksefjord is based on Røe, 1970, using the higher correlation.

KEY

520 Thickness of Older Sandstone Series where overlain by Smalfjord Tillite

695 Thickness of Older Sandstone Series where overlain by Mortensnes Tillite

10 Thickness of Smalfjord Tillite

by Bjørlykke (1967) and many earlier workers, most of whom focused their attention on Reusch's Moraine at Bigganjargga. The formation, 0 - > 100 m thick consists mainly of stratified conglomerate and sandstone, with tillite occurring only at and near the base. Nomenclature suggested by Bjørlykke (1967) for this area has not been applied here because it is not suited to the complexity of the formation. Instead, informal units have been established for each locality, and a tentative correlation is suggested between them (Chapter 4).

The Smalfjord Tillite around Tanafjord and Laksefjord has been described by Føyn (1937, 1967), Reading and Walker (1966) and Banks et al. (1971). The formation, 0 - 100 m thick (fig. 5), and possibly absent in some places (Føyn, 1937), consists mostly of unstratified tillite with intercalations of varved and laminated siltstone. Five informal members are recognised in the formation around Smalfjord (Chapter 5). Tentative correlations of the members with surrounding outcrops has been suggested, but correlations between the Tanafjord and Varangerfjord regions is uncertain as the necessary exposures have not been located.

On the basis of observations made in the Tanafjord area, it has been concluded that the Smalfjord Tillite-Nyborg Formation contact is, in part, slightly erosional. The erosion, though not very great, is of considerable sedimentological interest.

2.3 Nyborg Formation

The Nyborg Formation (Holtedahl, 1918) contains a wide range of lithologies and has been divided into five informal members during the present study. The basal lithologies are distinct from those in the Smalfjord Tillite; the contact usually appears sharp, though in detail may be erosive or gradational.

The five members of the Nyborg Formation are:

1) A basal discontinuous horizon of buff dolomite, overlain by dolomitic shale and purple shale. The member is about 5-50 m thick.

thick.

3) Alternating grey-green sandstone and shale, coarsening upward at the top over about 50 m; the total thickness is estimated at about 200 m.

4) Purple sandstone and grey-green shale and siltstone, up to 70 m thick.

5) White-grey sandstone with dolomite beds at the base, both up to about 25 m thick.

The greatest thickness of the Nyborg Formation is about 300 m in the Vestertana area (Føyn, 1937). To the east and west it is noticeably thinner, east of Leirpollen (fig. 5) about 8 m, and at Austerelva, about 30 m. The thinning is apparently due to erosion prior to the deposition of the Mortensnes Tillite, as facies in the Nyborg can be traced between widespread localities (e.g. Beynon et al. 1966, pp. 10-11). Important thickness and facies changes do occur however; these are discussed in Chapter 6.

Due to increasing erosion beneath the Mortensnes Tillite to the south, the younger members can be observed only in the north (fig. 6), (see also Reading and Walker, 1966).

2.4 Mortensnes Tillite Formation

The Mortensnes Tillite (Holtedahl, 1918) has been described in the Varangerfjord area by Reusch (1891), Holtedahl (1918), Rosendahl (1931) and Bjørlykke (1967), and in the Tanafjord area by Føyn (1937) and Reading and Walker (1966). The formation consists almost entirely of tillite, and it reaches its greatest thickness in the Vestertana area where the present study was concentrated (fig. 7). It has been correlated with the basal unit, a tillite, in the Borras Group at Alta (Føyn, 1964).

The Mortensnes Tillite cuts progressively down through the Nyborg Formation to the south, and rests on the Smalfjord Tillite and the Older Sandstone Series to the east, north of Varangerfjord (fig. 6). This unconformity was first detected on the Digermul

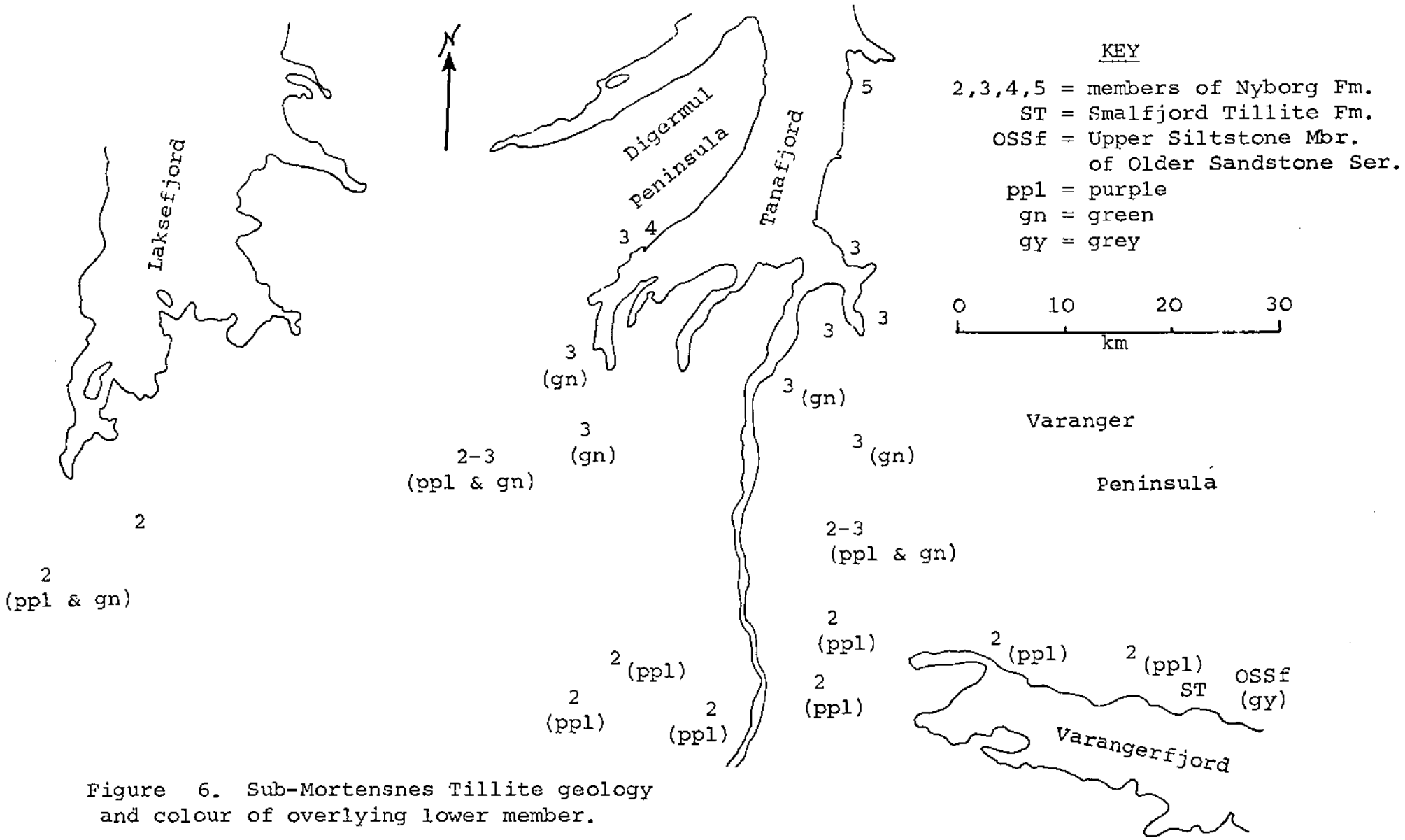

Figure 6. Sub-Mortensnes Tillite geology and colour of overlying lower member.

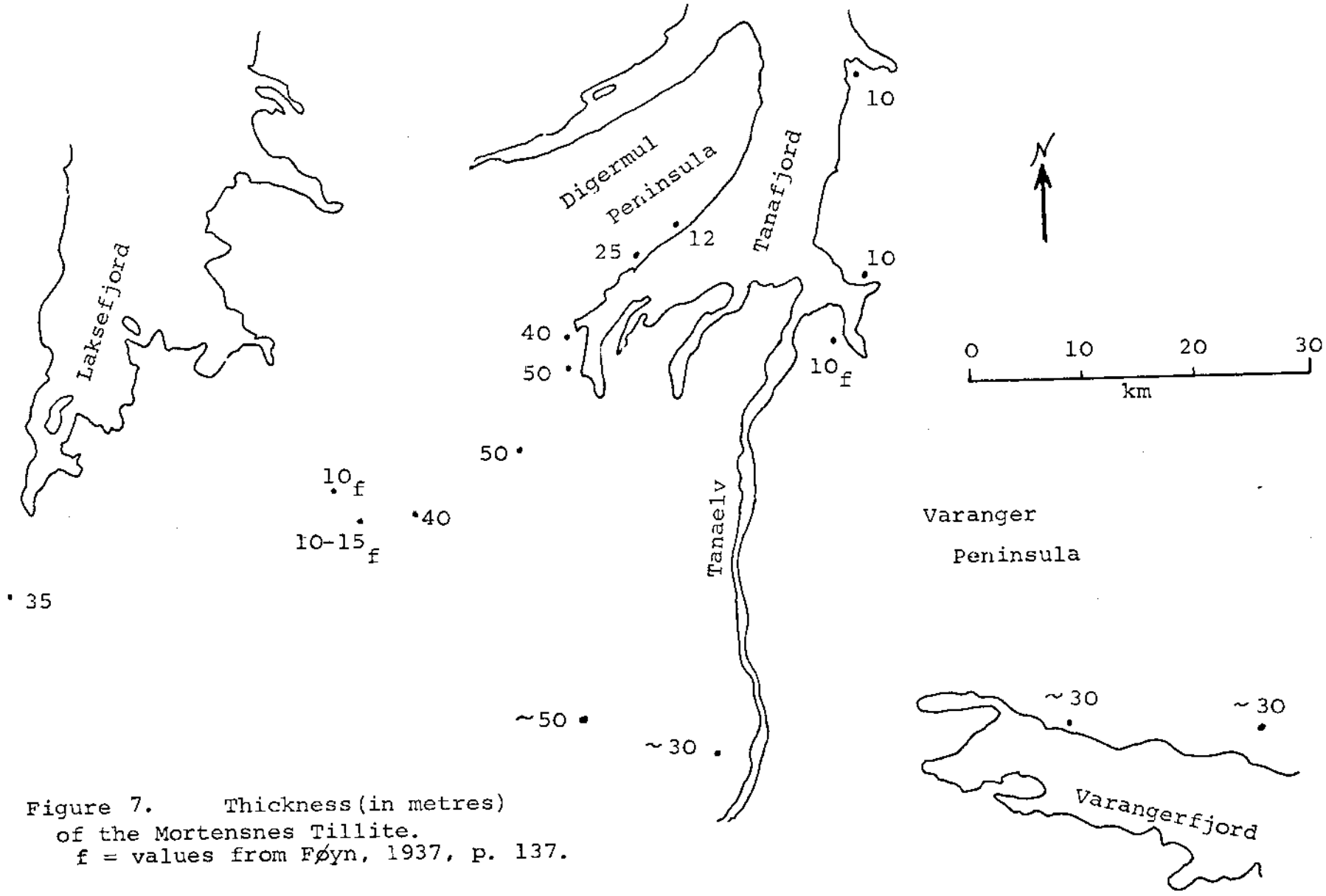

Figure 7. Thickness (in metres) of the Mortensnes Tillite.
f = values from Føyn, 1937, p. 137.

Peninsula by Reading and Walker (1966), who noted the southward dying out of units in the Nyborg Formation against the unconformity. A similar pattern has been observed in the Vestertana area. The slope on the unconformity along the Digermul is about 25' in a NE-SW direction, is about .09' between Larsholmen (see Chapter 7) and Trollfjord, and is about 13' in the Vestertana area in a NNE-SSW direction. Assuming an average slope of 10', 180 m would be eroded in a distance of 60 km, while with a slope of 15', 270 m would be eroded in the same distance.

The formation is subdivided into three informal members on the basis of composition, structure, and stratigraphical position. Brief accounts of these members are to be found in the introductory sections of Chapter 7.

In the Vestertana area the tillite is overlain gradationally by mudstones of the lower submember of the Lillevatn Member. However, to the north, a conglomerate bed caps the tillite, and this is overlain quite sharply by mudstones of the lower submember.

2.5 Lillevatn Member

The Lillevatn Member (Banks et al. 1971), the basal member of the Stappogiedde Formation, consists of dark shales in the lower part, the lower submember, and of sandstones and shales in the upper part, the upper submember. The lower submember is thicker in the south, up to 55 m (fig. 8), where it is termed the thick lower submember, and it characteristically forms a large-scale coarsening upwards sequence. In the north, the thin lower submember is 3-6 m thick and consists of sandy and silty mudstone. The upper submember maintains a nearly constant thickness of about 40 m over all the localities visited (as on fig. 8), and it erodes down slightly into the lower submember. It consists of fine conglomerate, coarse feldspathic sandstones, and fine sandstones and shales becoming more important upwards. These grade up into the red mudstones of the Innerelv Member.

The Lillevatn Member (upper submember) has been correlated

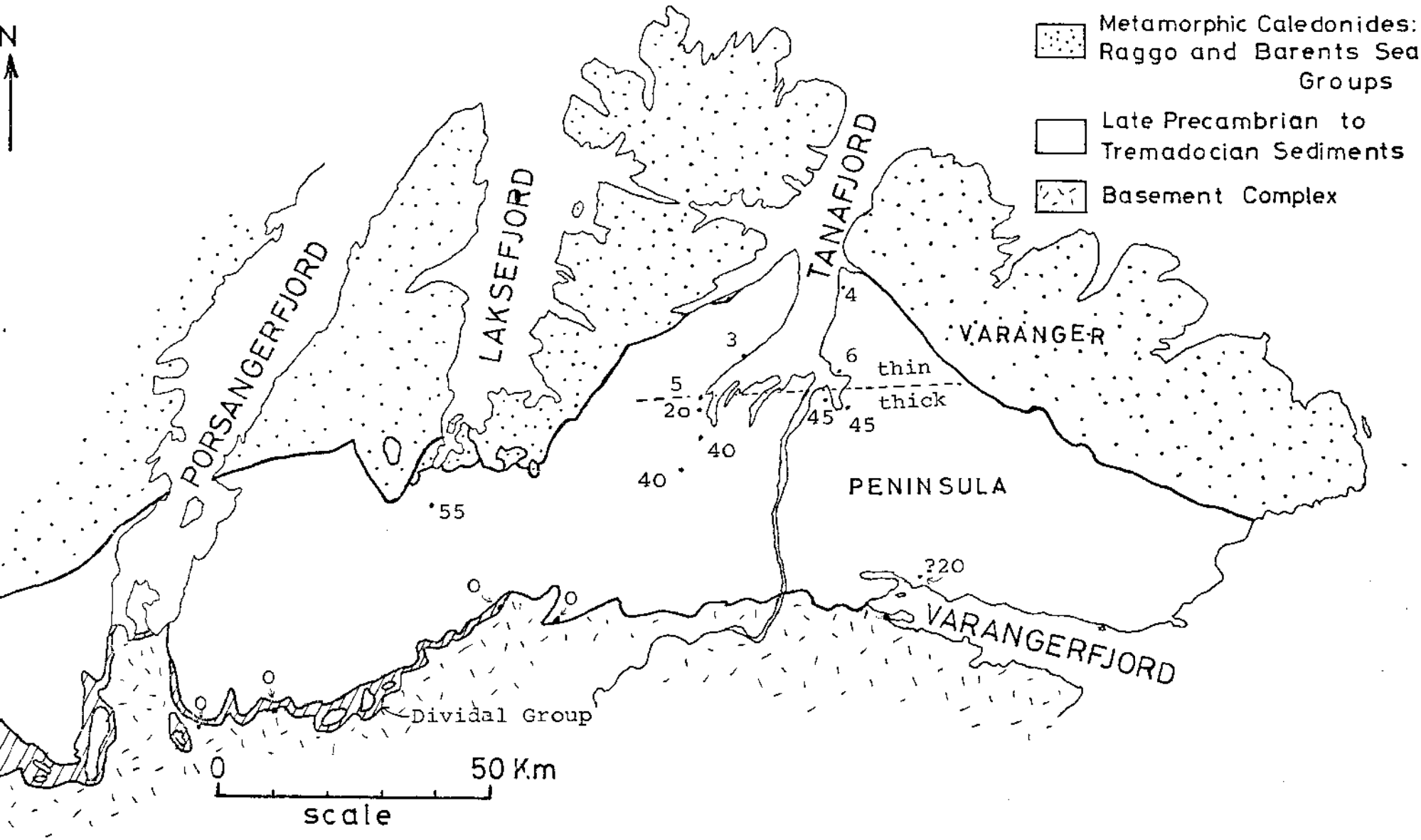

Figure 8. Thicknesses of the Lower Submember of the Lillevatn Member in Finnmark. Data from the Dividal Group are from Føyn, (1967).

with the basal part of the Dividal Group (Ledd I) where it outcrops in west Finnmark (Føyn, 1967), and it has been correlated with the conglomerate, sandstones and shales above the tillite and below the coloured shales in the Børras Group at Alta (Føyn, 1964).

The sandstones of the Lillevatn Member have been interpreted as fluvial in origin (Reading and Walker, 1966; Banks et al. 1971).