Polarforschung 60 (2): 117–120, 1990 (erschienen 1992)

13. Gradational East-West Increase in Metamorphism in the Basement Rocks of the Helliwell Hills, Wilson Terrane, North Victoria Land, Antarctica

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INTRODUCTION

During compilation work for a new geological map (GANOVEX-TEAM 1987) it became obvious that no systematic fieldwork had been carried out in the area of the Helliwell Hills although it had been visited several times (DOW & NEALL 1974, GREW & SANDIFORD 1982, COLLINSON & KEMP 1983, COLLINSON et al. 1986, HAMMER 1986).

When it became a serious possibility that important thrust planes discovered in the basement north of this area (FLÖTTMANN & KLEINSCHMIDT 1991) might continue through the Helliwell Hills (KLEINSCHMIDT this voe.) it was decided to revisit the area during GANOVEX VI.

Apart from the search for evidence for the above-mentioned thrust planes there were two more structural questions to be answered: (i) the nature of the contact between Beacon/Ferrar cover rocks and basement rocks (mapped as a fault by DOW & NEALL 1974) and, (ii) within the basement, the nature of the contact between low-grade rocks in Boggs Valley and high-grade rocks further west. - A gradational increase in metamorphism from phyllite to fibrolite-bearing micaschist on a 4.5 km long section had been described previously by GREW & SANDIFORD (1982) but without special reference to the location of the profile.

FIELD RESULTS

A one-day helicopter-supported reconnaissance mapping was carried out in the area (Fig. 1) with landings on many key outcrops. A first landing was made at the eastern mouth of Boggs Valley where a low-grade greywacke-phyllitic schist sequence crops out. Sedimentary structures like graded bedding are still preserved. This sequence is rather similar to the bulk of the basement rocks in the Morozumi Range further east and, as a sampling stop demonstrated, also on Onlooker Nunatak. Higher grade basement rocks and granites occur mainly along the western flank of the Helliwell Hills.

The cover rocks comprise Permian Beacon sediments and Jurassic Ferrar sills. Around Boggs Valley and at Mt. Bresnahan there occur thicker Beacon sequences in situ with a transgressive contact on the underlying basement but in most other areas the Beacon forms rafts within the Ferrar sills. Only in the northern part of the Helliwell Hills, between Dziura Nunatak and Mt. Bresnahan, basement and Ferrar are in clear fault contact. At Dziura Nunatak the throw on the clearly post-Jurassic Helliwell Fault is in the order of 300 m plus, with downthrow on the east side.
Another post-Ferrar fault, interpreted as an offset continuation of the Helliwell Fault has to be postulated between Komatsu Nunatak (elevation approx. 1840 m, basement granite) and Mt. van der Hoeven (elevation approx. 1940 m, Ferrar/Beacon cover). Downthrow to the E must have a minimum amount of 650 m, based on the

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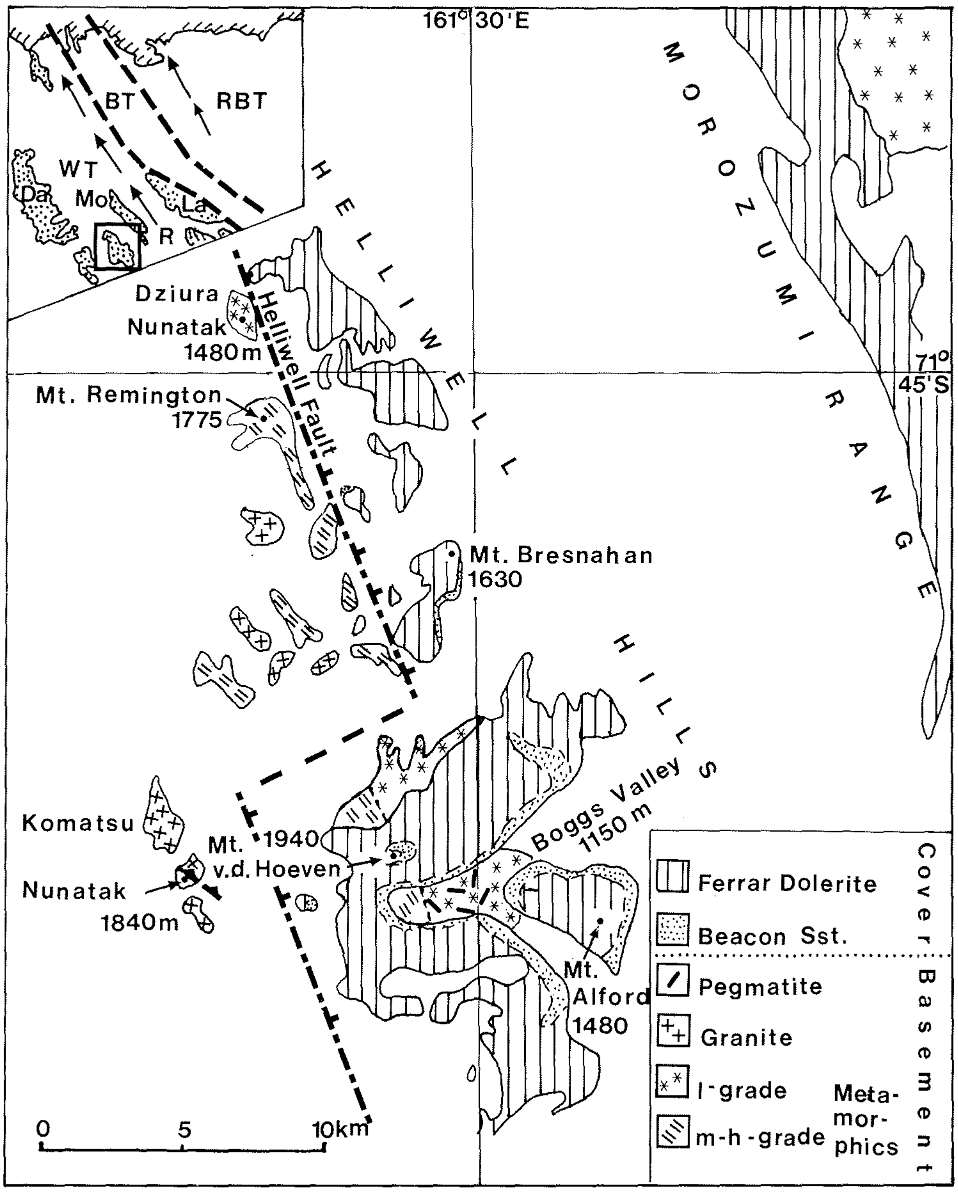

Fig. 1: Geological sketch map of the Helliwell Hills in the Rennick Glacier area, North Victoria Land.
Inset: WT = Wilson Terrane, BT = Bowers Terrane, RBT = Robertson Bay Terrane, R = Rennick Glacier, Da = Daniels Range, Mo = Morozumi Range, La = Lanterman Range.

Abb. 1: Geologische Kartenskizze der Helliwell Hills im Gebiet des Rennick-Gletschers, Nordvictorialand.
Abkürzungen in der Lageskizze: WT = Wilson Terrane, BT = Bowers Terrane, RBT = Robertson Bay Terrane, R = Rennick Gletscher, Da = Daniels Range, Mo = Morozumi Range, La = Lanterman Range.

difference in elevation of the Beacon base in Boggs Valley at 1150 m and the basement on Komsatsu Nunatak of up to 1840 m without Beacon cover. Thus, the Beacon/Ferrar cover rocks delineate a synclinal graben structure between Helliwell Hills and Morozumi Range.

In the basement,the degree of metamorphism, deformation and intrusive activity (pegmatite formation) increase rather dramatically from E to W. This can best be observed in Boggs Valley and, for the higher grade rocks, also on the parallel section SW of Mt. Bresnahan (Fig. 1).

Deformation intensifies from E to W. The easternmost phyllites at the lowest area of Boggs Valley are very similar to the rocks of the Morozumi Range. The rocks suffered simple deformation with rather tight, NW-SE trending folds with flat or gently plunging axes and a slaty cleavage with a dip direction of 40/80 (CLAR compass).

Towards the west, the deformation becomes more and more polyphase and in the W at least 3 phases of folding are recognizable. The main schistosity varies between 245/75 and 190/45 but is not measurable in the far west because the structures there consist of steeply plunging folds (300/70). In-between B-axes vary considerably, curve and seem to be more or less rotated into positions between 240/70 and 210/40, sometimes approaching the habit of sheathfolds. (This will be checked in oriented samples).

Because of our interest in a possible continuation of the thrust faults further north (KLEINSCHMIDT this volume) we have searched for evidence of thrusting rather carefully within the described section, but did not find a major thrust. There may be a hidden one under the ice to the E or W of Komatsu Nunataks. A minor thrust with transport direction top towards SW and a minimum transport of 5-10 m was observed on these nunataks (Fig. 2).

Metamorphism increases in Boggs Valley from low grade to medium or even high grade. The increase continues on the ridge SW of Mt. Bresnahan to biotite and muscovite-bearing micaschists and to sillimanite-bearing rocks in the westernmost outcrop on this ridge.

The formation of pegmatites begins halfway up Boggs Valley. They become thicker (several metres) and more frequent towards the W. They suffered at least one phase of folding. In the upper Boggs Valley small granitic dikes and bodies (some tens of metres) appear additionally. Larger granites form the Komatsu Nunataks to the W of Boggs Valley.

Fig. 2: Thrust plane in Komatsu Nunatak. View is towards the north; the top has moved towards the left (SW).

Abb. 2: Überschiebungsfläche im Komatsu Nunatak, Blick nach Norden. Die hangende Einheit ist nach SW (links) überschoben.

CONCLUSIONS

Our results confirm that there is in fact a dramatic increase in metamorphic grade from phyllites to fibrolite-bearing schists across 4.5 km of section as described already by GREW & SANDIFORD (1982). This increase is gradational, the effect of the later Helliwell Fault is unimportant. We think that the Helliwell Hills section provides important evidence for a very basic question in the geology of the Wilson Terrane.
The Terrane comprises low-grade and high-grade metamorphic rocks. One possible interpretation is the scenario of an older (Precambrian) high-grade basement covered by younger supracrustal sedimentary rocks. Both were then affected by the uniforming effects of metamorphism and plutonism of the Ross Orogeny (Cambrian/Ordovician). This setting would require a rather sudden change in grade between high-grade „basement" and lower-grade „supracrustals".
To the contrary, the Helliwell Hills section shows that there is rather a continuous transition from low-grade rocks to high-grade ones, at least in certain areas. - Other examples are Thomson Spur in the neighbourhood and the Priestley Glacier area inland from Terra Nova Bay. - This continuous increase rather argues against the basement/supracrustal scenario. The fact that the increase occurs over short distances is evidence for intense local heat doming during metamorphism.

Another important result are the observations on the character of the protolith for some of the metamorphic rocks in the Wilson Terrane. In Morozumi Range and Boggs Valley it is clearly turbiditic in character. This seems to be true for most of the Wilson Terrane from here to the N (Morozumi, Lonely One Nunatak (TESSENSOHN et al. 1981, GANOVEX-TEAM 1987), Thomson Spur (KLEINSCHMIDT & SKINNER 1981), Kavraiskiy Hills (SCHUBERT et al. 1984), Berg Mountains (SKINNER et al. in press), either as turbiditic phyllites or as biotite schists. In the Lanterman Range, the Outback Nunataks, Retreat Hills and Priestley schists there are carbonatic rocks and calcsilicates besides the just mentioned arenites. Thus the Wilson Terrane quite obviously comprises shelf and deep water protoliths. Volcanic components are generally rare.

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