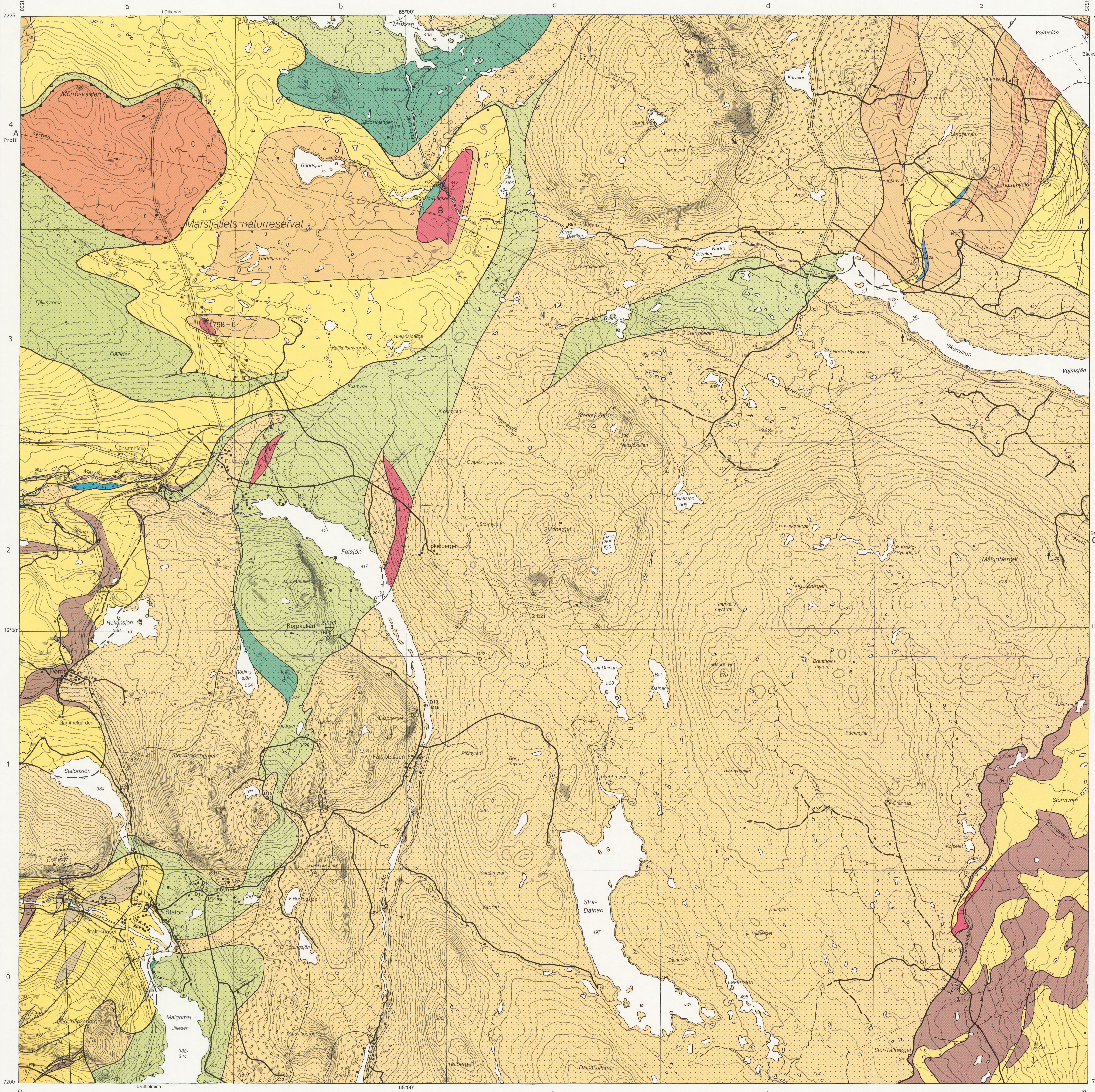


FJÄLLBERGGRUNDEN / *CALEDONIDES*

ÖVRE SKOLLBERGGRUNDEN / *UPPER ALLOCHTHON*

SEVEBERGARTER / *SEVE ROCKS*

- Glimmerskiffer, gnejs, i allmänhet granat-biotit-muskovit(±fengit)-förande; mindre inslag av amfibolit
  Mica schist, gneiss, generally garnet-biotite-muscovite(±phengite)-bearing; minor intercalations of amphibolite
- Överskjutning vid basen av Seve skollkomplexet
  Low-angle thrust at the base of the Seve Nappe Complex

MELLERSTA SKOLLBERGGRUNDEN / MIDDLE ALLOCHTHON

STALONSKOLLAN / *STALON NAPPE*

- Kvartsit, fältspatkvartsit, pelitiska inlagringar
  Quartzite, feldspathic quartzite, pelitic intercalations
- Meta-arkos, smärre konglomeratiska och pelitiska inlagringar
  Meta-arkose, minor conglomeratic and pelitic intercalations
- Konglomerat
  Conglomerate
- Mylonit, grönskifferaktig
  Mylonite, greenish, schistose
- Metagabbro, amfibolit, diabas (proterozoisk)
  Metagabbro, amphibolite, dolerite (Proterozoic)
- Granit till syenit, gnejs (proterozoisk)
  Granite to syenite, gneiss (Proterozoic)
- Överskjutning vid basen av mellersta skollberggrunden
  Low-angle thrust at the base of the Middle Allochthon

UNDRE SKOLLBERGGRUNDEN / *LOWER ALLOCHTHON*

BLAIKSKOLLAN / *BLAIK NAPPE COMPLEX*

Tåsjögruppen / *Tåsjön Group*

- Kalksten, lerskiffer, gråvacka (ordovicium) / *Limestone, shale, greywacke (Ordovician)* — Norråkerformationen / *Norråker Formation*
- Alunskiffer (kambrium–understa ord.) med orstensbollar och/eller kalkstenslager / *Alum shale (Cambrian–L. Ordovician) with stinkstone lenses and/or limestone layers* — Fjällbrännaformationen / *Fjällbränna Formation*

Sjoutälvsgruppen / *Sjoutälven Group*

- Grön och/eller röd skiffer / *Green and/or red shale*
- Gröngrå lerskiffer, större inlagringar / *Grey-green shale, major intercalations* — Gärdsjöformationen / *Gärdsjön Formation*
- Kvartsit med lerskifferinlagringar / *Quartzite with shale intercalations*
- Tillit, varvskiffer / *Tillite, glacial claystone* — Långmarkbergsformationen / *Långmarkberg Formation*

Risbäcksgruppen / *Risbäck Group*

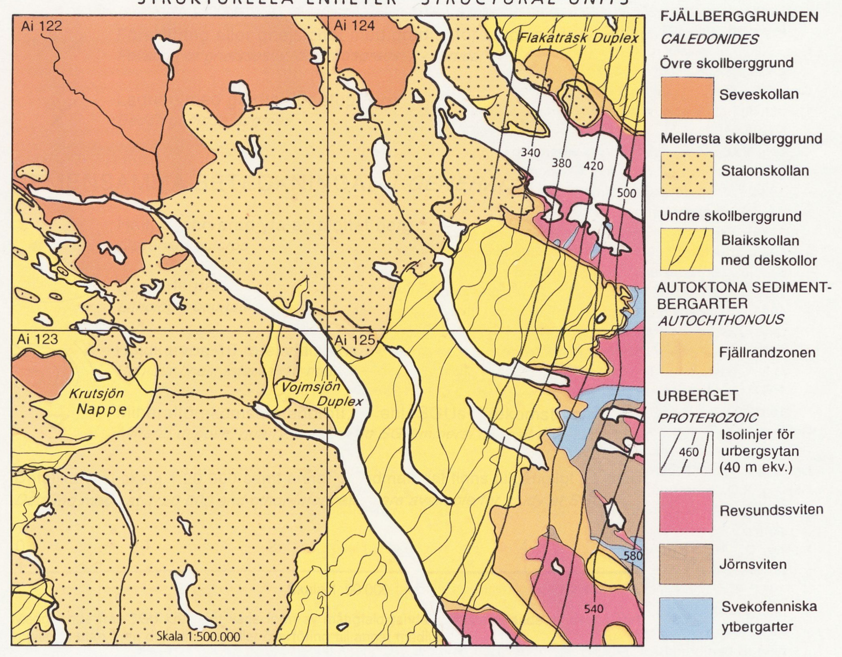
- Dolomit, delvis oren med kvartsrika inslag / *Dolomite, partly impure quartzite* — Kalvbergsformationen / *Kalvberget Formation*
- Arkos (sparagmit) med skifferinlagringar / *Arkose with shale intercalations*
- Konglomerat / *Conglomerate*

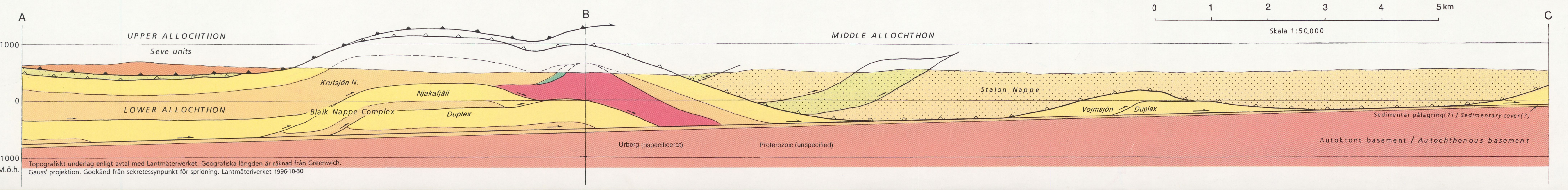
- Gabbro, amfibolit, diabas (proterozoisk)
  Gabbro, amphibolite, dolerite (Proterozoic)
- Granit till syenit (proterozoisk)
  Granite to syenite (Proterozoic)
- Överskjutning vid basen av undre skollberggrunden **(endast i profilen)**
  *Low-angle thrust at the base of the Lower Allochthon **(only in the cross-section)***

BETECKNINGAR / *SYMBOLS*

- Radiometrisk åldersbestämning / *Isotopic age determination*
- Uppåtbestämning / *Way-up determination*
- Lineation p.g.a. mineralorientering eller skärande förskiffringar med gradtal för stupning / *Mineral lineation or intersection lineation, plunge in degrees*
- Veckaxel med gradtal för stupning / horisontell / *Fold axis, plunge in degrees / horizontal*
- Förskiffring med gradtal för stupning / horisontell / *Foliation, schistosity, dip in degrees / horizontal*
- Lagring med gradtal för stupning / *Bedding, compositional layering, dip in degrees*
- Bergartsgräns / *Lithologic boundary*
- Överskjutning repeterande tidigare skollgränser / *Out-of-sequence thrust, breaching thrust*
- Överskjutning mellan delskollor, mindre överskjutning / *Minor low-angle thrust*
- Häll, observerad yta av blottat berg / *Observed outcrop*
- Bh Kärnborrhål / *Drillhole site*
- Stalontunnelns sträckning / *Trace of tunnel to hydroelectric power station*
- Mineralförekomst, stenbrott; nr enl. SGUs förekomstregister / *Mineral deposit, quarry; no. acc. to SGU mineral deposit register*
- Höjdkurvor, 10 m ekvidistans / *Contour lines, interval 10 metres*

STRUKTURELLA ENHETER *STRUCTURAL UNITS*





Topografiskt underlag enligt avtal med Lantmäteriverket. Geografiska längden är räknad från Greenwich. Gauss' projektion. Godkänd från sekretessynpunkt för spridning. Lantmäteriverket 1996-10-30

Kartering och sammanställning av det geologiska kartbladet 23G Dikanäs SV bygger i huvudsak på de geologiska arbeten som periodvis under åren 1978–1997 bedrivits av R.O. Greiling, universitetet i Heidelberg, och hans studenter, delvis i samarbete med SGU och Lapplands Natursten. I fältarbetena på detta blad har J. Bartusch, F. Bierlein, S. Febbroni, R.O. Greiling, R. Kumpulainen, F. Roos och E. Zachrisson deltagit.

För den slutliga sammanställningen och beskrivningen svarar R.O. Greiling och E. Zachrisson. Design- och layoutarbeten har utförts av av E. Zachrisson, reproduktionsarbetet av Ingemar Källberg, skrivarbeten av Kerstin Finn och stilsättning av Agneta Ek.

Referens till kartan: Greiling, R.O. & Zachrisson, E., 1999: Berggrundskartan 23G Dikanäs SV, 1:50.000. *Sveriges geologiska undersökning Ai 123.*

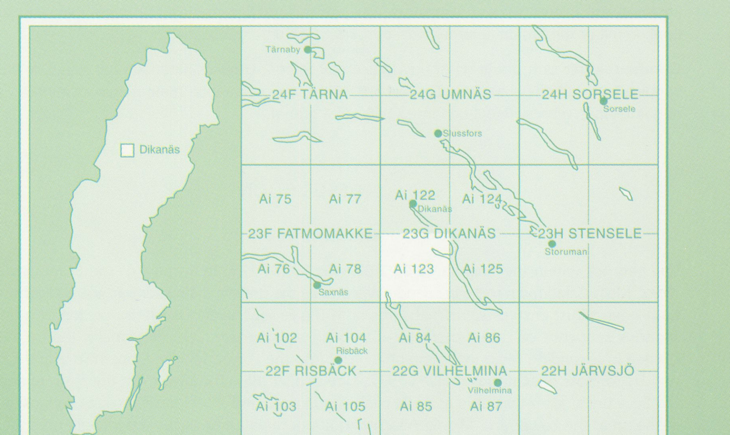
SGU serie Ai nr 123

Berggrundskartan

23G Dikanäs SV

Bedrock map

Skala 1:50 000



SGU
Sveriges Geologiska Undersökning

1999

KORTFATTAD BESKRIVNING

Kartbladen 23G Dikanäs (Ai 122–125) täcker ett område, som består av både urberg och fjällberggrund. En översikt över de strukturella enheterna inom kartbladen lämnas i kartdiagrammet nedanför teckenförklaringen. Berggrunden inom de två västliga bladen tillhör helt den kaledoniska fjällkedjan, medan de båda östliga bladen även innefattar en zon av urbergsbergarter öster om fjällkedjan. Dessa är av tidigproterozoisk ålder (2500–1600 miljoner år), medan fjällkedjans bergarter och den tunna, underlagrande zonen av odeformerade sedimentbergarter (se profilen) avsattes för ca 700–450 miljoner år sedan. Fjällberggrundens deformation, metamorfos och framskjutning mot öster och sydost, ut över urbergsunderlaget, ägde rum under kaledonisk tid och avslutades för ca 400 miljoner år sedan. Kartbladet 23G SV består således uteslutande av fjällberggrund.

FJÄLLBERGGRUNDEN

Berggrunden inom den kaledoniska fjällkedjan är resultatet av en bergskedjebildning för ca 520–400 miljoner år sedan. Iapetus, det hav som i senproterozoisk tid gränsade till kontinenten Baltica, började då att minska i bredd. Havsbottenskorpan sjönk ner i subduktionszoner, och kontinenterna Baltica, Laurentia (Nordamerika och Grönland) och eventuellt andra, mindre fragment av kontinentalskorpa kolliderade och pressades ihop. Genom storstilade överskjutningar kom därvid omfattande bergartskomplex att skjutas upp över den fennoskandiska urbergsskölden, vars västra randzoner samtidigt kraftigt deformerades. Sådana överskjutna enheter benämnes skollor och kan ha transporterats flera hundratals kilometer åt öster eller sydost. De översta skollorna har i regel de längsta transportavstånden, medan de undre enheterna är mer lokala och ofta innehåller bergarter, som med stor sannolikhet tillhört det fennoskandiska urbergsunderlaget.

Ur topografisk synpunkt är den nuvarande fjällkedjan betydligt yngre och i huvudsak relaterad till den tertiära uppsprickning för ca 65 miljoner år sedan, som ledde till bildandet av den nuvarande Atlanten.

Tektonisk indelning

Fjällberggrunden, som i regel vilar på en tunn zon av rotfasta (autoktona), sedimentära bergarter (se profilen), uppbygges internt av ett stort antal tektoniskt överskjutna (alloktona) enheter. Dessa kan indelas i den undre, mellersta, övre och översta skollberggrunden. Den senare är ej representerad inom de nu aktuella kartbladen.

De tektoniskt sett lägsta enheterna representeras av den undre skollberggrundens Blaikskolla, vilken dominerar i bladets västra del (Njakafjällduplexen och den överlagrande Krutsjöskollan). Den undre skollberggrunden återkommer även i öster, längst i nordöst som del av den s.k. Vojmsjöduplexen. Genom bladets centrala del, i ett synformartat stråk med nordnordöstlig riktning, löper mellersta skollberggrundens Stalonskolla. Seveskollan, som har sin största utbredning på NV-bladet, representeras endast av en utliggare med glimmerskiffrar i trakten av Mörrösjöliden (4a).

Bergarternas ålder

Utifrån påträffade fossil samt genom geologiska bedömningar och jämförelser med angränsande områden kan man bestämma eller uppskatta bergarternas ålder.

I den undre skollberggrunden, som ibland innehåller medrivna rester av urbergsunderlaget, dominerar senproterozoiska arkoser, senproterozoiska–underkambriska kvartsiter, kambriska (–underordoviciska) alunskiffrar samt, i mycket underordnad mängd, ordoviciska skiffrar och gråvackor. Bestämbara fossil saknas inom kartbladet.

Den mellersta skollberggrunden består huvudsakligen av meta-arkoser och fältspatkvartsiter, troligen av senproterozoisk ålder, men innehåller även medrivna rester av det gamla, kristallina underlaget. Syenitiska bergarter i sådana linser, tillhörande den undre (ruta 3a) och mellersta (ruta 8e) skollberggrunden, har genom U/Pb-bestämningar på zirkoner daterats till 1798±6 resp. 1768±21 miljoner år.

Seveskollans glimmerskiffrar bildades troligen ur senproterozoiska sandstenar och skiffrar, på angränsande kartblad i regel med inslag av amfibolit, representerande mafiska magmabergarter, som trängde upp vid Iapetus-havets öppnande.

Metamorfos

I samband med bergskedjeveckningen och överskjutningarna utsattes bergarterna för ökat tryck och förhöjd temperatur, vilket ledde till att de omvandlades genom den process som kallas metamorfos (omkristallisation och mineralnybildning). Den undre skollberggrunden karakteriseras av ringa eller låg metamorfos (anchi-zon), vilken bäst kan mätas genom graden av kristallinitet hos lermineralet illit (och klorit). Mellersta skollberggrunden föreligger i grönskifferfacies (delvis lägre amfibolitfacies) men har i regel utsatts för retrograd metamorfos, relaterad till överskjutningarna. Sevebergarterna uppvisar högre metamorfos och har i allmänhet nått amfibolitfacies.

Bergarter

Beroende på utgångsmaterialet och som följd av variationer i deformation och metamorfos föreligger inom kartbladsområdet följande huvudbergarter:

Arkos, som dominerar den pre-tillitiska lagerföljden i den undre skollberggrunden, har bildats ur fältspatrika, relativt grova, delvis konglomeratiska sandstenar. Innehållet av kalifältspat och hematit ger vissa av dem en rödaktig färgton, men även grå eller mörkare varianter är vanligt förekommande. Ljusare, kvartsitiska led ingår också. I äldre tid användes beteckningen "sparagmit" för dessa senproterozoiska bergarter.

(Fortsättning på kartans baksida / Continued on the back of this map sheet)

MALMER, INDUSTRIELLA MINERAL OCH BERGARTER

SGU för ett register över malmer och mineraliseringar, vilka i fjällkedjan har beteckningen OREC, i urberget ORED, och över förekomster av industriella mineral och bergarter med beteckningen ORED.

Inom kartområdet saknas intressanta malm- och mineraluppslag.

1993 påbörjade Lapplands Natursten undersökningar av Stalonskollans gröna myloniter för möjlig användning till sågade och polerade skivor, främst för fasadbeklädnad. De största insatserna har skett vid Korpkullen (ORED 5503, ruta 2b), där 7 st kärnborrhål och provbrytning (genom diamantsågning) utförts.

Sprängmaterial från Stalontunneln har använts för vägar och annan byggnation.

Främst under 1980-talet utförde Vattenfall undersökningar inom det s.k. Fatsjöprojektet för en eventuell vattenöverföring från Vojmsjön (Vikenviken, ca 410 m.ö.h.) till nordligaste spetsen av Malgomaj (340 m.ö.h.) med ett planerat kraftverk vid Fatsjön. Geofysiska markmätningar och ett flertal diamantborrhål utfördes. 16 av borrhålen finns inlagda på den geologiska kartan. Det maximala djupet uppgår till 150 m.

Detaljkartor i skala 1:20 000 samt annat grundmaterial finns tillgängligt på SGU.
Detailed maps at 1:20 000 and other information are available for study at SGU.

SGU Ser. Ai nr 123
BERGGRUNDSKARTAN
23G DIKANÄS SV

Tillit är beteckningen på en förstenad morän i den senproterozoiska lagerföljden. Dess förekomst indikerar en istid för ca 600 miljoner år sedan. Varvskiffer, som kan uppträda i anslutning till tilliterna, representerar en glaciallera, ofta med identifierbara droppstenar, som lossnat från smältande isberg.

Kvartsit utgör huvuddelen av den post-tillitiska lagerföljden i den undre skollberggrunden. Den är lokalt mycket ren (>98% kvarts) men i regel något fältspatförande. Till skillnad från arkoserna (se ovan) utgöres dock fältspaten nästan enbart av plagioklas, som vid vittring ofta ger vita fläckar. I vissa horisonter, främst i den undre delen, är kvartsiten grövre, ibland konglomeratisk.

Alunskiffer är en lerskiffer med hög halt av organiskt material (bitumen), vilket gör den svart och sotande. Den har i regel också ett relativt högt innehåll av svavel samt, framförallt i den övre delen, förhöjda halter av vissa tungmetaller såsom uran, vanadin, molybden och nickel och av brännbara kolväteföreningar (kerogener). Sitt namn har den fått av att den tidigare nyttjades för framställning av alun, som används vid färgning och inom pappers-, läder- och läkemedelsindustrin.

Meta-arkos betecknar en något omvandlad, fältspatrik sandsten, som dominerar inom Stalonskollan. På grund av metamorfosen har de från början troligen rödaktiga sandstenarna antagit en grå–grönaktig färgton. Ljusa, mera kvartsitiska led och konglomeratiska inlagringar ingår. I äldre tid använde man beteckningen 'sparagmit' även för dessa senproterozoiska bergarter.

Mylonit är inom kartbladet en hård, flintig, tätbandad bergart, som bildats genom nedkrossing och rekristallisation i utpräglade rörelsezoner. De grönskifferaktiga myloniterna inom Stalonskollan tros ha uppkommit ur gabbroida–intermediära bergarter från urbergsunderlaget.

Glimmerskiffer och gnejs utgör huvuddelen av Seven. Utgångsmaterialet har mestadels utgjorts av sandiga och lerhaltiga sediment, vilket lett till att den nuvarande mineralogin domineras av kvarts, något fältspat, glimrar (biotit och muskovit) samt granat.

DESCRIPTION

General geology

The bedrock within the map sheet 23G Dikanäs SV (Ai 123) forms part of the Scandinavian Caledonides. Most Caledonian rocks in Scandinavia and all the units in the present area are allochthonous and have been thrust east- or southeastwards onto the Fennoscandian platform, on top of a thin, autochthonous sequence of Late Proterozoic–Cambrian sedimentary rocks. Regionally, the Caledonides are divided in ascending tectonostratigraphic order into the Lower, Middle, Upper (Seve and Köli Nappes) and Uppermost Allochthons (Kulling 1972, Gee et al. 1985). The lowermost units, up to and including the Seve units, are interpreted as parts of the imbricated and shortened margin of Fennoscandia. Within the area, the Lower and Middle Allochthon are dominated by clastic cover sequences, derived from the continent Baltica, but also contain slices of Proterozoic basement.

All units have a complex tectonic and metamorphic history. The Middle Allochthon and the Seve Nappes were probably affected by a Late Cambrian–Early Ordovician event, which produced greenschist- and higher grade metamorphic mineral assemblages. Deformation and metamorphism continued, and the various complexes were successively brought together along a suture zone formed during collision of the continents Baltica and Laurentia. After nappe emplacement onto the Fennoscandian platform and establishment of the Lower Allochthon in the Silurian–Early Devonian, the Caledonian activity faded out.

Tectonostratigraphic units

The geological units distinguished on the map are principally lithological or lithostratigraphic in character. Tectonic units are separated by major and minor thrusts, as demonstrated by the main map, the cross-section and the structural inset map. Three major allochthons occur within the present map sheet, described in ascending order below. The autochthonous basement and the thin, autochthonous, sedimentary cover are only shown as undifferentiated units in the cross-section. For additional information, reference is made to the map sheet adjacent to the east (23G SO).

LOWER ALLOCHTHON

The Lower Allochthon is built up of structural slices or horses, mostly composed of sedimentary (cover) sequences and minor parts of underlying, crystalline rocks, derived from the basement.

The *crystalline, basement-derived rocks* are invariably represented by coarse-grained granites or syenites, which are comparable with the Revsund granite, exposed in the autochthonous basement (Greiling 1982). This similarity has been confirmed by radiometric dating results of 1798 ± 6 Ma (U/Pb on four fractions of separated zircons, P.-O. Persson, pers. comm.) from a syenite at Mörrösjöbäcken (3a). These rocks are characterized by a porphyric texture of cm-sized microcline phenocrysts in a mm-size groundmass of plagioclase, orthoclase and quartz, with some primary biotite. Although the primary texture is mostly well-preserved, quartz shows undulatory extinction and some grains are broken or bent. Also some feldspar grains show traces of brittle deformation. Mafic, crystalline rocks are restricted to one occurrence of medium-grained amphibolite, enclosed within granitoid rocks at Matskanån (4b).

The *sedimentary succession* of the Lower Allochthon is correlated with the Jämtland Supergroup in the type area further south (Gee et al. 1974, 1978, Kumpulainen 1982). The Risbäck Group (with arkose units and the Kalvberget Formation), the Sjoutälven Group (with Långmarkberg and Gärdsjön Formations) and the Tåsjön Group (with Fjällbränna and Norråker Formations) are represented within the map sheet. The thickness of the sedimentary rocks is, in general, lower than in the type area.

The **Risbäck Group** at the western border of the map sheet is contiguous with the type area further southwest (Kumpulainen 1982, Zachrisson 1997) and broadly comparable. The sequence is from several metres to at least several hundred metres thick. It represents the upper part of the Risbäck Group, but the correlation with the proposed stratigraphy in the type area (Kumpulainen 1982: Stor-Raijan (bottom), Tvärselet and Mångmanberget Formations) is uncertain. In the section along Mörrösjöbäcken (3a), to the east of the road Stalon-Dikanäs, the sequence starts with coarse, often conglomeratic arkoses with dark to light reddish colours, directly on top of the crystalline basement rocks. In the Bäckstrand area (4–5, e–f, at the corner of all four 23G map sheets), Kulling (1942) discussed the red conglomerates as part of the Stalon Nappe. It is worth noting, that the present interpretation involves a subdivision with an upper part of greenish-greyish colour belonging to the Stalon Nappe, underlain by horses of reddish Risbäck arkoses and conglomerates of the Vojmsjön Duplex (see below), as part of the Lower Allochthon. The conglomerates of the Lower and Middle Allochthon are distinct both by their different degrees of metamorphism and their pebble contents (see Middle Allochthon, below).

Dolomites of the **Kalvberget Formation** have been identified only as a minor layer in the northeastern part of the present area (3e), but occur ca 1 km further north (23G NV, 5b) and more frequently ca 8 km further west on the Fatmomakke map sheet (23F SO).

West of Tjärnmyrliden (4e) and within several horses along the upper Marsån valley (2a), the reddish arkoses are overlain by tillites of the **Långmarkberg Formation**. The tillites vary considerably both in facies development and in thickness (up to ca 30 metres). The most comprehensive description as yet of the area's tillites is by Kulling (1942). Varved 'clays' with grain sizes up to silt and fine sand occur, probably beneath the tillites 'sensu stricto'. The overlying tillites contain angular to sub-angular, up to metre-sized boulders of crystalline, granitoid rocks and arkoses in a psammo-pelitic matrix. Locally, pelite or dolomite fragments also occur.

The **Gärdsjön Formation** is dominated by massive, often white to light grey-coloured quartzites, composed mainly of quartz (>90%), with minor amounts of feldspar, detrital mica, clay minerals and chlorite. The grain size varies between coarse and very fine-grained; particles are well rounded in graded units, and generally more angular in poorly sorted beds. A characteristic layer of conglomeratic and coarse-grained quartzite occurs near the base of the Gärdsjön Formation, ca10 metres thick. It is composed of generally well-rounded pebbles of milky or bluish quartz and white feldspar, up to 1.5 cm in diameter. Within the quartzite, irregular layers of silt- and mudstone and grey, green and sometimes red shale occur. These fine-grained layers are also composed of at least 90% quartz. Some layers are more than 10 metres thick and can be followed along strike for several kilometres, as shown on the map. Towards the top of the Gärdsjön Formation, psammites show graded bedding and a general fining upwards. The last few metres beneath the overlying Fjällbränna Formation are characterized by an alternation of fine sandstones, siltstones and dark grey, impure carbonates and marls. Recent stratigraphic work has shown that this uppermost part of the Gärdsjön Formation is related to an Early Cambrian flooding event of ca 530 Ma age (late Tommotian), which can be recognized both in the autochthonous cover sequences and in the Lower Allochthon in the whole of the Scandinavian Caledonides (Vidal and Moczydlowska 1996, Greiling et al. 1999).

The **Fjällbränna Formation** contains black mudstones and shales (alum shale) composed of fine-grained, mainly submicroscopic clay minerals and variable contents of quartz and/or carbonate, sulphides (mostly pyrite) and organic matter. Andersson et al. (1985) give a stratigraphic age range of the Swedish alum shales from Middle to Late Cambrian and locally earliest Ordovician. A trilobite of late Middle Cambrian age (*Lejopyge laevigata*) has been found in a limestone lens in black shale 800 metres to the west of this map sheet (Gee 1972). Within the present map area, only minor shelly fragments could be found in a lens of black limestone (2a).

The alum shale of the Fjällbränna Formation shows a gradational contact towards the overlying Norråker Formation, the highest stratigraphic unit of the Lower Allochthon in the area.

In places, the base of the **Norråker Formation** is marked by the appearance of cm to dm thick interlayers within the alum shale of dark grey to black, impure limestones, which grade upwards into dark grey to brownish marls. Higher up, the marls and grey mudstones show cm–dm thick interlayers of greywacke beds. Whereas the Norråker Formation is extensively developed towards the south (e.g. Zachrisson and Greiling 1996, Greiling et al. 1996), it is restricted to one minor occurrence on the present map sheet (2a).

Structurally, the Lower Allochthon is represented by the Blaik Nappe Complex (Kulling 1942) and has been divided earlier, on the map sheets adjacent to the south and west (e.g. Zachrisson and Greiling 1993, 1996), into several thrust systems. On the present map, the Lower Allochthon is exposed in parts of two major, regional antiforms trending NNE–SSW, which were caused by the stacking of the Njakafjäll Duplex (Gayer and Greiling 1989) in the west and marginal thrust systems in the east. These two antiforms are separated by a synform, which is occupied by the overlying Middle Allochthon. Towards north, the generally NNE-striking horses of the Njakafjäll Duplex terminate in an irregular pattern, and some of the horses are bent into an E–W orientation with dips towards north along the valley of the upper Marsån river. As a consequence, the roof thrust of the Njakafjäll Duplex dips northwards beneath the overlying Krutsjön Nappe sheet (Zachrisson and Greiling 1993), which represents the highest unit of the Lower Allochthon and extends into the northwestern part of the present map sheet (3–4, a–c). The E–W trending lateral margin of the Njakafjäll Duplex acted effectively as a lateral ramp, albeit with an oblique angle to the nappe transport direction (110°, see below). This geometry gave rise to local, N–S directed compression in the overlying units, as expressed in E–W-trending buckle folds and out-of-sequence thrusts with a southward movement. At the eastern Caledonian margin it cannot be distinguished, whether the major part of the marginal thrust system is a duplex or an imbricate fan, due to the erosion of a putative roof thrust. However, in the northeastern corner of the present map sheet, a number of horses could be mapped out, which have the base of the Middle Allochthon as their common roof thrust. Therefore, this structure can be demonstrated to be a duplex. It is called the Vojmsjön Duplex here and extends towards east and north into the adjacent map sheets (23G NO, NV, SO).

The structural and metamorphic evolution involves a single pre-thrusting deformation phase, which produced small-scale, isoclinal or drag folds and a penetrative foliation in incompetent rocks, synchronous with illite recrystallization (Greiling 1985). Subsequent shearing and thrusting relate to nappe transport and stacking of horses, and the latter also led to folding in the overlying units. Stretching lineations and branch line geometry suggest a tectonic transport direction towards the ESE (ca 110°), which is consistent for all the horses in the Lower Allochthon (Gayer and Greiling 1989). Finally, a late out-of-sequence, reverse fault transported a slice of the Lower Allochthon over the Middle Allochthon (Daikanvik, 5e).

Illite crystallinity data define a 'metamorphic' grade between lower anchizone and epizone (Greiling 1985, Warr et al. 1996).

MIDDLE ALLOCHTHON

The Middle Allochthon is represented by the Stalon Nappe (Kulling 1942, 1955), which is widely distributed and generally present between the Lower and Upper Allochthons. The area around the village of Stalon with the mountains Lill- and Stor-Stalonberget gave rise to the name of the Stalon Nappe (Kulling 1951). It can be divided lithologically into crystalline, pre-Caledonian, basement-derived rocks in various degrees of deformation, including mylonites, and metasedimentary, generally psammitic rocks. The different lithological units are separated by shear zones, and primary basement/cover relationships are not preserved (Greiling 1984a, 1985, 1986, 1989).

The *crystalline basement-derived rocks* are represented by abundant greenish mylonites, subordinate felsic gneisses and metagabbros (Greiling 1985, Zachrisson and Greiling 1996, Roos 1997). The greenish mylonites ("green schists of Ullisjaur type" of Kulling 1942; see 23G NO) consist of plagioclase, epidote, chlorite and subordinate mica-minerals, quartz and opaque minerals. They were probably derived mainly from crystalline, pre-Caledonian rocks, as determined from microscopic and geochemical studies (Greiling 1985, 1992). The mylonites vary from relatively homogeneous and weakly foliated to distinctly banded (dark green – light green) and foliated. Because of their aesthetic appeal, they have been quarried as potential dimension stones at Korpkullen (2b, Einarsson and Greiling 1997, Greiling and Febbroni 1997, Roos 1997). Less deformed, crystalline rocks appear as coarse-grained metagabbros with lens-shaped, dark and light mineral grains or pseudomorphs. Microscopic studies show a complete change of the primary mineralogy into chlorite, epidote, albite and accessory minerals. No felsic rocks have been observed in the Middle Allochthon of the present map sheet. However, farther north a metasyenite from the road to the east of Harrvik (23G NV, 8e) yielded a radiometric age of 1768 ± 21 Ma (U/Pb on five fractions of separated zircons, P.-O. Persson, pers. comm.).

The lower part of the overlying *metasedimentary sequence* is dominated by coarse conglomerates in a psammitic, competent matrix. These conglomerates are fining upwards in that psammitic interlayers become more frequent. Higher up, the conglomeratic beds become thinner and are restricted to the base of dm–m thick psammite beds. Eventually, there is a transition towards thick-bedded, homogeneous, coarse meta-arkoses with rare, metapelitic beds as thin (mm–cm), dark grey interlayers or occasionally as angular fragments within the psammites. Apparently overlying the metapsammites but with no primary contact exposed is another type of conglomerate with less abundant boulders in a relatively fine-grained, shaly or phyllitic matrix. The matrix sometimes shows transitions into a psammitic composition so that no clear distinction can be made between the two types of conglomerates. Lithological similarities suggest a correlation of the sedimentary sequence of the Stalon Nappe with the Risbäck Group of the Lower Allochthon. However, the Stalon units are distinct by their higher degree of metamorphism (greenschist versus sub-greenschist grade, see below), by the intensity of deformation and by the conglomerate's pebble contents. According to pebble statistics (Kulling 1942), the conglomerates in both allochthons are dominated by boulders of granite, syenite, felsic gneiss, vein quartz, feldspar megacrysts and rhyolite. Conglomerates of the Lower Allochthon are distinct by containing up to 20% of boulders derived from clastic, metasedimentary rocks (pelites-psammites). In contrast, no metasedimentary fragments are reported from Middle Allochthon conglomerates. Instead, the latter may contain up to 30% of mafic boulders, whereas in the Lower Allochthon the content of mafic boulders is 10% or less.

At Storforsen in Matskanån (4b), a sequence of alternating, greenish pelites and cm–dm thick, light grey quartzites and arkoses is exposed. The unit is at least 20 metres thick, and can be followed along strike for several kilometres towards northeast (see 23G NV). There, this sequence is in an overturned position and apparently overlying the bulk of metasedimentary rocks of the Stalon Nappe. The lithologic character strongly resembles, and may be speculatively correlated with, the Gärdsjön Formation of the Lower Allochthon. Such a correlation is consistent with the position as the highest, metasedimentary unit of the Middle Allochthon. However, this sequence is clearly epimetamorphic, in contrast to the anchimetamorphic Lower Allochthon.

Structure. Early Caledonian deformation in the Middle Allochthon is documented by recumbent, isoclinal folds with a penetrative schistosity, deformed by generally open folds, attributed to a second structural phase. These latter folds are associated with an axial planar crenulation cleavage that may be penetrative in incompetent rocks. Subsequent deformation led to intense shearing and development of a penetrative, mylonitic fabric in some structural units. In other units, penetrative deformation was restricted to their margins or to distinct, internal shear zones with only a weak overprinting by a fracture cleavage. Associated with the planar, mylonitic fabric is a strong lineation enclosing both relic mineral grains and newly formed minerals, indicating a tectonic transport direction towards the SE–SSE (ca 140°). Later fault-bend folding occurred, when the Middle Allochthon was transported as the roof of the Lower Allochthon.

Mineral assemblages representing an early peak of *metamorphism* are characterized by coexisting almandine garnet, biotite and muscovite in pelitic rocks and are indicative of the transition between greenschist and amphibolite facies metamorphism with minimum P-T conditions of about 500°C and 4 kb. Subsequent mylonitization is associated with retrogression of garnet and brown biotite into coexisting muscovite, chlorite, green biotite and rare stilpnomelane in pelitic rocks, indicating lower greenschist facies metamorphic conditions. Less deformed domains still retain higher grade assemblages, that remained apparently unaffected by retrogression.

UPPER ALLOCHTHON

The higher-grade rocks in the structurally lower part of the Upper Allochton are included within the Seve Nappe complex. The Seve rocks of the 23F Fatmomakke area immediately to the west were studied and described by Trouw (1973). The present map area is covered by what he called the Eastern Schist and Amphibolite Belt, which in this context includes the Grytsjö schists (Zachrisson and Greiling 1993). The schists vary from muscovite-dominated mica schists with abundant biotite and garnet porphyroblasts to more quartzo-feldspathic, gneissic varieties or more quartz-rich, metapsammitic rocks.

Particularly the quartz-rich metapsammitic units of the Seve and Stalon Nappes are lithologically very similar. However, they can be distinguished by the following criteria: in the Seve units, muscovite is well recrystallized (mm–cm size), biotite and garnet porphyroblasts are visible with a hand-lens (or even without), quartz and feldspar are recrystallized, in general there are no primary textures preserved; foliation surfaces appear as (medium) grey with brownish hue (from biotite). In the Stalon Nappe (Middle Allochthon), foliation surfaces are 'phyllitic' and appear dark grey with greenish hue (from chlorite or epidote). Macroscopically, there are neither muscovite nor biotite crystals visible. Biotite or garnet can only exceptionally be observed in thin sections; quartz is recrystallized, but the primary shape of clastic grains can often be observed; feldspar clasts are often well preserved. Locally, primary features such as cross-bedding or graded bedding can be discerned.

Cross-section

Contouring of the top of the peneplained, Proterozoic basement at the Caledonian front indicates a west-northwesterly dip in the interval 0.6°–1.7°. The Caledonian, basal décollement surface is generally developed within the sedimentary cover sequence a few tens of metres above and broadly parallel with the basement surface. Therefore, the section is drawn assuming a sole thrust with a general dip of 1.5° (cf. Gee et al. 1978, Bierlein and Greiling 1993) from the eastern Caledonian margin towards the west-northwest. It trends at a low angle to the tectonic transport direction of the Lower Allochthon (110°). Previous sections across the Njakafjäll Duplex have been published by Kulling (1972), Gayer and Greiling (1989) and Zachrisson and Greiling (1993, 1996). The present section shows the buried, northern termination of the Njakafjäll Duplex, which is overlain by the Krutsjön Nappe sheet (Zachrisson and Greiling 1993). The latter is composed of a basement slice, which is primarily overlain by the Risbäck Group and the Sjoutälven Group. The Risbäck Group can be seen to thin around the basement rocks. In the easternmost part of the section, the trailing end of the marginal thrust system is just visible. The synformal areas between the antiformal structures of the Lower Allochthon are occupied by the Stalon Nappe of the Middle Allochthon, which is probably riding directly on top of the autochthonous, sedimentary sequence. The dominating metapsammites of the Stalon Nappe are imbricated together with horses of basement-derived mylonites.

LITERATURE

Andersson, A., Dahlman, B., Gee, D.G. and Snäll, S., 1985: The Scandinavian alum shales. *Sveriges geologiska undersökning Ca 56*, 50 pp

Bierlein, F.-P., 1990: Geologische Kartierung im Unteren und Mittleren Allochthon der Schwedischen Kaledoniden südlich Stalon in Süd- Västerbotten, Schweden. *Diplom-Kartierung, Universität Heidelberg*. *Sveriges geologiska undersökning BRAP 93003*, 82 pp.

Bierlein, F.-P. and Greiling, R.O., 1993: New constraints on the basal sole thrust at the eastern Caledonian margin in northem Sweden. *Geologiska Föreningens i Stockholm Förhandlingar 115*, 109–116.

Einarsson, Ö. and Greiling, R.O., 1997. Natursteine in Nordschweden. *Naturstein 1997/5*, 137–139.

Gayer, R.A. and Greiling, R.O., 1989: Caledonian nappe geometry in north- central Sweden and basin evolution on the Baltoscandian margin. *Geol. Mag.126*, 499–513.

Gee, D.G., 1972: The regional, geological context of the Tåsjö uranium project, Caledonian front, central Sweden. *Sveriges geologiska undersökning C 671*, 36 pp.

Gee, D.G., Karis, L., Kumpulainen, R. and Thelander, T., 1974: A summary of Caledonian front stratigraphy, northern Jämtland, southern Västerbotten, central Swedish Caledonides. *Geologiska Föreningens i Stockholm Förhandlingar 96*, 389–397.

Gee, D.G., Kumpulainen, R. and Thelander, T., 1978: The Tåsjö décollement, central Swedish Caledonides. *Sveriges geologiska undersökning C 742*, 35 pp.

Gee, D.G., Kumpulainen, R., Roberts, D., Stephens, M.B., Thon, A. and Zachrisson, E., 1985: De skandinaviska Kaledoniderna. Tektonostratigrafisk karta, 1:2 milj. *Sveriges geologiska undersökning Ba 36*. (English version, SGU Ba 35.)

Greiling, R.O., 1982: Precambrian basement complexes in the north- central Scandinavian Caledonides and their Caledonian tectonic evolution. *Geologische Rundschau 71*, 85–93.

– 1984a: Structure and metamorphism at the base of major, far-travelled nappes: an example from the Middle Allochthon of the central Scandinavian Caledonides. *Science Géol. Bull. 37*, 13–22.

– 1984b: Fatsjö Power Plant, Geology and Tectonics. *Sveriges geologiska undersökning BRAP 93009*, 21 pp.

– 1985: Strukturelle und metamorphe Entwicklung an der Basis grosser, weittransportierter Deckeneinheiten am Beispiel des Mittleren Allochthons in den zentralen Skandinavischen Kaledoniden (Stalon Deckenkomplex in Västerbotten, Schweden). *Geotektonische Forschungen 69*, 129 pp.

– 1986. Photogeological approach to structural analysis of polydeformed domains. *International Basement Tectonics Association Publication 5*, 285–291.

– 1989: The Middle Allochthon in Västerbotten, northern Sweden: Tectonostratigraphy and tectonic evolution. *In* R.A. Gayer (ed.): *The Caledonide geology of Scandinavia*, 69–77. Graham & Trotman, London,

– 1992: Geochemical analyses from the Västerbotten Caledonides. *Sveriges geologiska undersökning BRAP 92010*, 16 pp.

Greiling, R.O., Zachrisson, E., Björk, L. and Kero, L., 1996: Berggrundskartan 22 G Vilhelmina NO, 1:50 000. *Sveriges geologiska undersökning Ai 86*.

Greiling, R.O. and Febbroni, S., 1997. L'industria della pietra naturale in Svezia. *AZ Marmi 126*, 64–68.

Greiling, R.O., Jensen, S. and Smith, A.G., 1999: Vendian–Cambrian subsidence of the passive margin of western Baltica. – Application of new stratigraphic data from the Scandinavian Caledonian margin. *Norsk Geologisk Tidsskrift 79*.

Kulling, O., 1942: Grunddragen av fjällkedjerandens bergbyggnad inom Västerbottens län. *Sveriges geologiska undersökning C 445*, 320 pp.

– 1951: Böra begreppen Stalonskollan, Blaikskollan och Offerdalskollan bibehållas? *Geologiska Föreningens i Stockholm Förhandlingar 73*, 492–504.

– 1955: Den Kaledoniska fjällkedjans berggrund inom Västerbottens län. *In* S. Gavelin, S. and O. Kulling: Beskrivning till berggrundskarta över Västerbottens län. *Sveriges geologiska undersökning Ca 37*, 101–296.

– 1972: The Swedish Caledonides. *In* L.U. de Sitter (ed.): *Scandinavian Caledonides*, 149–285. Wiley Interscience, London,

Kumpulainen, R., 1982: The Upper Proterozoic Risbäck Group, northern Jämtland and southwestern Västerbotten, central Swedish Caledonides. *Univ. Uppsala, Dept. Mineral. Petrol., Res. Report 28*, 60 pp.

Roos, F. G., 1997: Strukturen in den Myloniten des Mittleren Allochthons sowie deren Bewertung als Naturstein-Rohstoff. *Diplom-Arbeit, Ruprecht-Karls-Universität, Heidelberg*. *Sveriges geologiska undersökning BRAP 98004*, 153 pp.

Trouw, R.A.J., 1973: Structural geology of the Marsfjällen area, Caledonides of Västerbotten, Sweden. *Sveriges geologiska undersökning C 689*, 155 pp.

Vidal, G. and Moczydlowska, M., 1996: Vendian–Lower Cambrian acritarch biostratigraphy of the central Caledonian fold belt in Scandinavia and the palaeogeography of the Iapetus–Tornquist seaway. *Norsk Geologisk Tidsskrift 76*, 147–168.

Warr, L.N., Greiling, R.O. and Zachrisson, E., 1996: Thrust-related, very low- grade metamorphism in the marginal part of an orogenic wedge, Scandinavian Caledonides. *Tectonics 15*, 1213–1229.

Zachrisson, E., 1997: Berggrundskartorna 22F Risbäck, 1:50 000. *Sveriges geologiska undersökning Ai 102–105*.

Zachrisson, E. and Greiling, R.O., 1993: Berggrundskartorna 23F Fatmomakke NO och SO, 1:50 000. *Sveriges geologiska undersökning Ai 77–78*.

– 1996: Berggrundskartan 22G Vilhelmina NV, 1:50.000. *Sveriges geologiska undersökning Ai 84*.