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ORIGINAL PAPER

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U–Pb ages of the Dalsfjord Complex, SW Norway, and their bearing on the correlation of allochthonous crystalline segments of the Scandinavian Caledonides

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Abstract The Dalsfjord Complex is an allochthonous crystalline unit in the hanging wall of a major extensional detachment of the Caledonian orogen on the western coast of Norway. U–Pb geochronology has been carried out to test a previously proposed correlation between this unit and the Jotun Nappe Complex, a member of the Middle Allochthon now occupying a foreland position to the east. A monzonite sample of the Dalsfjord suite yields a zircon age of 1,634±3 Ma, whereas a crosscutting gabbro was formed at 1,464±6 Ma. Both rocks were strongly overprinted during the Sveconorwegian orogeny, especially the monzonite whose zircons U–Pb data were strongly pulled towards a lower intercept age of 882±29 Ma, and whose titanite indicates a two-stage growth history at >960 Ma and <920 Ma. These relationships support the correlation of these units with the Jotun Complex, and to some degree also with the Lindås Nappe in the Bergen Arcs.

Keywords Caledonides · Dalsfjord · Jotun · U–Pb geochronology · Zircon · Titanite · Proterozoic

Introduction

The crystalline rocks of the Middle Allochthon of the Scandinavian Caledonides are dominated by metaplutonic complexes, generally of monzonitic-syenitic to gabbroic-anorthositic composition but locally also ranging to peridotitic and granitic end members (e.g., Bryhni and Sturt 1985). The largest and most typical unit in this system is the Jotun Nappe Complex, a NE-trending body of plutonic rocks and orthogneisses located in the structurally depressed portion of the Caledonides in central Norway, the 'Faltungsgraben' of Goldschmidt (1912; Fig. 1). In his 1916 monograph, Goldschmidt (1916) described the lithological similarity between the rocks of the Jotun Nappe Complex and those of the Lindås Nappe (present terminology) in the Bergen Arcs, assigning them to his 'Bergen-Jotun Stamm (clan)'. He also briefly described a third occurrence of this suite in the region between Dalsfjord and Fördefjord on the west coast of Norway, which had originally been reported by Irgens and Hiortdahl in 1864 and by Reusch in 1881 (as cited by Kolderup 1922). These rocks were then investigated in greater detail by Kolderup (1922), who reported petrographic descriptions and some chemical analyses. The evidence available at that point in time was interpreted as indicating a Caledonian age of intrusion of the Dalsfjord, Jotun and Bergen suites (Goldschmidt 1916; Kolderup 1922), but this view was eventually superseded by the realization that these were Precambrian allochthons, tectonically overthrust over crystalline basement and Paleozoic sedimentary units (Kolderup 1928). The Precambrian origin of the Jotun and Lindås nappes was later demonstrated by U–Pb and Rb–Sr dating, which also provided evidence for a multistage genesis characterized by several magmatic events between 1,700 and 1,250 Ma, and a complex Sveconorwegian magmatic and metamorphic evolution at 950 to 900 Ma (Schärer 1980; Cohen et al. 1988; Corfu and Emmett 1992; Boundy et al. 1997; Kühn et al. 2000; Bingen et al. 2001). By contrast, no direct U–Pb dating has yet been carried out on rocks of the Dalsfjord Complex and, although the Jotun and Dalsfjord systems are commonly considered to be tectonic correlatives (e.g., Milnes et al. 1997; Andersen et al. 1998), a direct demonstration of this assumption remains to be given. The purpose of this study was to fill this gap by looking at the age and isotopic systematics of the most typical lithologies of the Dalsfjord magmatic suite.

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Geological framework

A dominant structural element of the Sunnfjord area is the Nordfjord-Sogn detachment zone (NSDZ; Figs. 1 and 2), which juxtaposes a series of allochthonous units (upper plate) against the eclogitized crystalline basement of the Western Gneiss Region (WGR; lower plate). The allochthonous units comprise the Dalsfjord magmatic suite at the base, with its unconformably overlying Høyvik Group metasedimentary cover, itself unconformably overlain by low-grade Silurian deposits of the Herland Group, which is followed by the discordant Sunnfjord Melange and by the allochthonous Solund-Stavfjord ophiolite (Brekke and Solberg 1987; Andersen et al. 1990). The uppermost unit in this area is the Devonian sedimentary rocks of the Kvamshesten Group, which developed during post-collisional extension of the Caledonian orogen (Osmundsen et al. 2000).

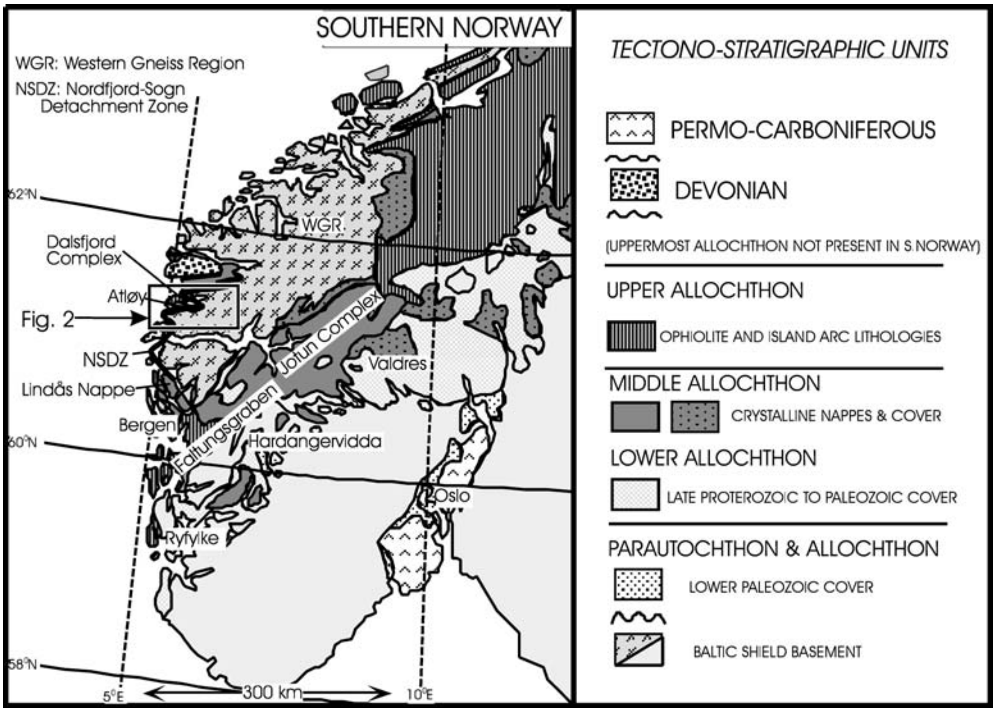

Fig. 1 Tectonostratigraphic map of southern Norway

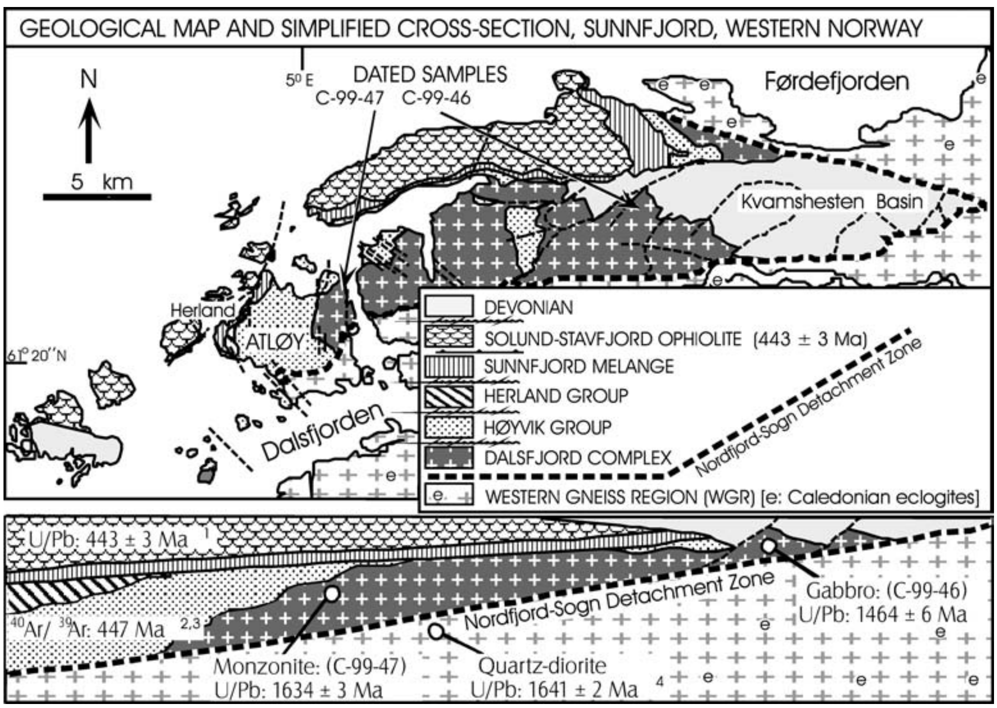

Fig. 2 Geological map (*top*) and schematic cross section (*bottom*) of the studied area in Sunnfjord showing the location of the dated rocks and summarizing the most relevant radiometric ages in the area (from this study and *1* Dunning and Pedersen 1988, *2* Andersen et al. 1998, *3* Eide et al. 1999, *4* Skår et al. 1994)

The Dalsfjord Complex comprises largely syenitic to monzonitic rocks with minor gabbroic and anorthositic (albitite) units (Kolderup 1922, 1928). In general the felsic rocks contain biotite and/or locally hornblende. Gabbroic units are partly coronitic and generally strongly retrogressed. Kolderup (1922) proposed the name 'Mangeritsyenit' for the dominant felsic rock type of the suite to account for the similarity of its SiO_2 content to that of syenite and the presence of Ca-bearing microperthitic mesoperthite typical of mangerite.

The Høyvik Group consists of (presumed) late Precambrian to Ordovician (?) quartzites, meta-arkoses and local schists and marbles which underwent polyphase deformation and greenschist facies metamorphism during an Ordovician event, as indicated by $^{40}Ar/^{39}Ar$ ages of ca. 447 Ma (Andersen et al. 1998; Eide et al. 1999). The sequence was subsequently exhumed to permit the unconformable deposition of the transgressive fluvial to marine sedimentary sequence of the Herland Group in the Silurian (Wenlock; Brekke and Solberg 1987; Andersen et al. 1990). Incidentally, this period of exhumation and deposition corresponded to the time of obduction of the 443±3 Ma Solund-Stavfjord ophiolite on top of the Herland Group, with concurrent deformation and development of the Sunnfjord Melange.

The two samples analyzed in this study represent the dominant monzonitic rock type and one of the gabbroic bodies in the Dalsfjord magmatic suite (Fig. 2).

Analytical techniques

The samples were crushed in a jaw crusher and pulverized in a hammer mill before mineral separation was performed using a Wilfley table, Frantz magnetic separators and heavy liquids. The minerals were picked under a binocular microscope, abraded (Krogh 1982), and dissolved at 185 °C in Teflon bombs (zircon) or on a hotplate in Savillex vials (titanite), using a $^{205}Pb/^{235}U$ spike for the ID determination. Zircon was processed in minicolumns with HCl (modified from Krogh 1973).

Two of the titanite analyses were carried out with the normal two-stage procedure using HBr–HCl–HNO_3 (e.g., Corfu and Stone 1998 and references therein), whereas the other two fractions were separated using a new single-stage technique. This technique is based on the observation that both Pb and U are strongly retained on anion exchange resin (Dowex AG 1X-8, 200–400 mesh) in a medium of 3.1 N HCl+0.5 N HBr, whereas the other disturbing elements can be flushed out from the column. The residual HBr is then removed from the resin by passing 3.1 N HCl before collecting the Pb and U with 6 N HCl and H_2O, respectively.

The purified Pb and U were loaded (together) on outgassed Re filaments with Si gel and phosphoric acid and measured with a MAT262 mass spectrometer in static mode or, for small amounts of Pb and all $^{207}Pb/^{204}Pb$ ratios, in dynamic mode using an ion-counting ETP multiplier. The data were corrected for 0.1%/amu fractionation on both Pb and U, with an additional adjustment to correct for an exponential SEM bias determined from regular runs of the NBS 982 Pb standard. Blank correction was 2 pg Pb and 0.1 pg U for zircon, and 10 pg Pb and 0.3 pg U for titanite. The initial Pb was corrected using Pb compositions calculated with the Stacey and Kramers (1975) model, with uncertainties of 1% on the $^{207}Pb/^{204}Pb$ and 2% on the $^{206}Pb/^{204}Pb$ ratios. These uncertainties, which affect most strongly the calculation of titanite ages, cover a large range of possible Pb initial compositions to be expected in these rocks. The results were plotted and regressed using the software of Ludwig (1999). The decay constants are those of Jaffey et al. (1971). Uncertainties in the isotopic ratios and the ages are given and plotted at 2 sigma.

Results

Monzonite (sample C-99-47)

This sample is a medium- to coarse-grained and strongly foliated to gneissic monzonite collected on the Island of Atløy, ca. 1.5 km structurally above the NSDZ and ca. 250 m structurally below the contact with the unconformably overlying Høyvik Group (Fig. 2). The mafic minerals are generally retrogressed to greenschist facies assemblages, but pyroxenes of the original mangeritic paragenesis are still locally preserved. The sample yielded an abundant population of zircon, dominantly with short-prismatic and euhedral to subhedral shapes. Cathodoluminescence examination reveals the presence of very well-developed, regular oscillatory growth zoning, but also of local domains of homogeneity having either bright or low luminescence at the margins of some grains (HD in Fig. 3). These homogeneous domains suggest that some secondary recrystallization took place locally, presumably during metamorphism.

The three U–Pb analyses (Fig. 4a; Table 1) are quite discordant, even though they were carried out on abraded gem-quality zircon material. Nevertheless, they fit very well on a discordia line defining an upper intercept age of 1,634±3 Ma, which is interpreted to date the magmatic crystallization of the monzonite, and a lower intercept age of 882±29 Ma which can be linked to its metamorphic evolution.

Evidence for a rather complex metamorphic history is also provided by the titanite data. The titanite in this sample is commonly somewhat turbid, reflecting the presence of local alteration. Inclusions of other minerals are also common. These unfavorable characteristics of the titanites were likely the cause of their relatively high, common Pb contents of 4 to 20 ppm (Table 1; normally 1–3 ppm; Corfu and Stone 1998), which express themselves in the relatively poor precision of the analyses. In thin section the titanite can be observed forming clusters together with epidote in the vicinity of oxide grains, and locally it consists of densely turbid (and polycrystalline?) grains surrounded by rims composed of clear eu-

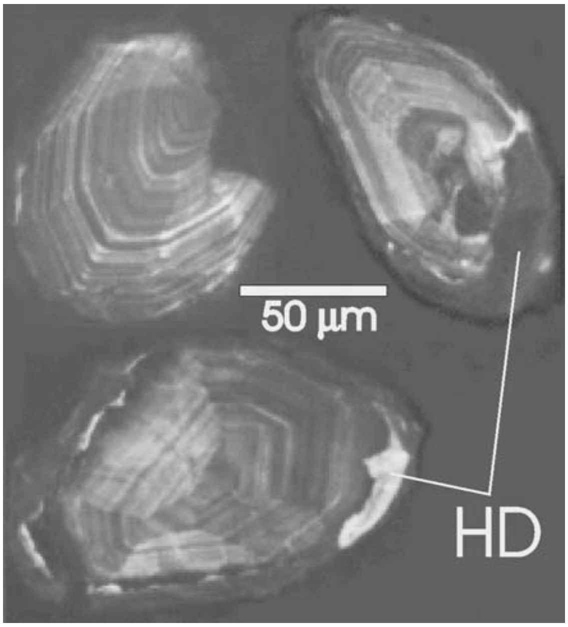

Fig. 3 Cathodoluminescence images of polished zircon crystals from monzonite sample C-99-47. The pictures reveal an intense oscillatory growth zoning, likely produced during the original Gothian magmatic crystallization event, and local homogeneous, bright or dark domains (*HD*), probably indicating local recrystallization of zircon during the Sveconorwegian metamorphism

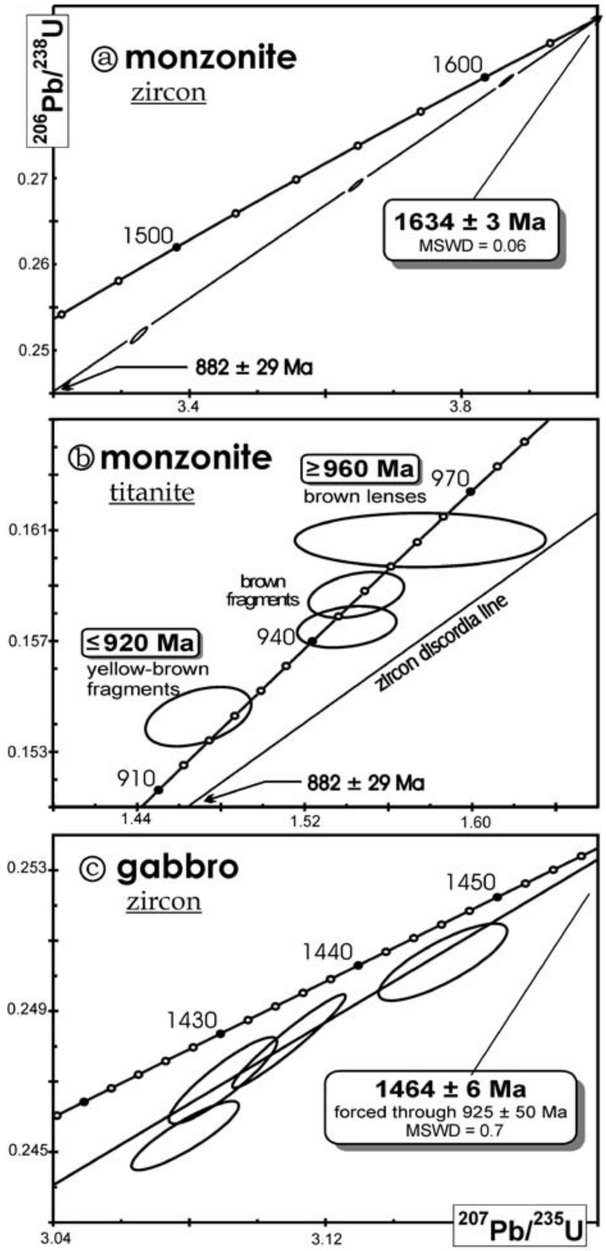

Fig. 4 Concordia diagrams with U–Pb data for **a** zircon and **b** titanite in monzonite sample C-99-47, and **c** zircon data for gabbro C-99-46. Error *ellipses* and ages are given at 2 sigma

hedral crystals. Although it was generally difficult to separate grains with really distinct appearances, the four analyses yield a distinct age dispersion (Fig. 4b). The oldest analysis, at around 960 Ma, was obtained from a selection of lensoidal, somewhat turbid grains whereas three fractions of variously brown to yellow titanites yield apparent ages of about 950–940 and 925 Ma. The decrease in age correlates with a decrease in darkness and in U content of the grains. Although these are very common features of multigeneration titante populations (e.g., Ketchum et al. 1997; Corfu and Stone 1998; Søderlund et al. 1999), in the present case a visual distinction between old and young titanite domains/grains is very difficult to achieve. The two dates of ca. 960 and 920 Ma can thus only be viewed as lower and upper age limits, respectively, for the two events which formed the titanite. Because of the poor analytical precision it cannot be excluded that the older age component may represent an original magmatic titanite generation (1,634 Ma), present as cores in metamorphic (<920 Ma) titanite. Alternatively, both components could be metamorphic, and record different stages of the Sveconorwegian evolution of the monzonite.

As shown in Fig. 4b, the discordia line defined by the zircon analyses passes below, and outside of error of, the titanite data points, intersecting concordia at 882±29 Ma. It is possible that this lower intercept age may be somewhat too young, reflecting a tilting of the discordia line by a superimposed Pb loss event during the polyphase Caledonian orogeny (or more recently). The alternative is that the lower intercept is correct and the age, within its large error, reflects the metamorphic event which caused Pb loss from the zircon. Such an event would presumably also coincide with the time of crystallization of the younger titanite component.

Gabbro (sample C-99-46)

The sample was collected from a pegmatitic patch within a little-deformed segment of a larger gabbroic body intrusive into the monzonitic Dalsfjord suite near Stordals-

Table 1 U–Pb data

Mineral, characteristics[a]	Weight[b] (μg)	U[b] (ppm)	Th/U[c]	Pbc[d] (ppm)	Pbc[d] (pg)	^{206}Pb/^{204}Pb[e]	^{207}Pb/^{235}U[f]	2 σ[g]	^{206}Pb/^{238}U[f]	2 σ[g]	ρ	^{206}Pb/^{238}U[f] (Ma)	^{207}Pb/^{235}U[f]	^{207}Pb/^{206}Pb[f]	2 σ[h]
C-99-47 monzonite, Atløy															
Z eu eq-sp (*n*=30)	39	423	0.38	–	2.1	139,506	3.866	8	0.28128	52	0.97	1,598	1,607	1,617.9	1.0
Z eu-sb sp (*n*=21)	140	70	0.36	–	9.9	16,715	3.645	8	0.26928	56	0.95	1,537	1,559	1,589.6	1.2
Z (eu) fr (*n*=11)	35	695	0.23	–	7.0	54,540	3.327	10	0.25209	75	0.93	1,449	1,487	1,542.3	2.1
T lenses ts(-tu) y-b (*n*=14)	28	151	0.36	20	–	88.2	1.575	49	0.16065	80	0.01	960	961	961	63
T fr ts b (y) (*n*=14)	81	130	0.52	5.4	–	244	1.545	19	0.15866	68	0.36	949	948	946	23
T fr tl(-tu) b(-y) (*n*=30)	203	130	0.38	6.5	–	208	1.540	19	0.15751	61	0.27	943	947	955	25
T fr tl(-tu) y(-b) (*n*=40)	160	106	0.51	4.6	–	233	1.469	21	0.15426	88	0.41	925	918	901	26
C-99-46 pegmatitic gabbro, Stordalsvatn															
Z fr ts (*n*=2)	<1	>341	1.21	–	7.0	783	3.154	15	0.25039	90	0.81	1,440	1,446	1,454	6
Z fr ts (*n*=1)	<1	>474	1.22	–	0.8	9,248	3.109	14	0.24815	109	0.96	1,429	1,435	1,444.0	2.3
Z fr ts (*n*=1)	<1	>527	4.25	–	0.8	9,785	3.090	13	0.24703	100	0.90	1,423	1,430	1,441	4
Z fr ts (tu) (*n*=1)	<1	>333	0.66	–	2.1	2,405	3.079	13	0.24546	80	0.87	1,415	1,427	1,446	4

[a] Z, Zircon; T, titanite (all the minerals abraded); eu, euhedral; sb, subhedral; eq, equant; sp, short prismatic (l/w=2–4); fr, fragment; b, brown; y, yellow; ts, transparent; tl, translucent; tu, turbid; (), subordinate property; *n*, number of grains in fraction
[b] Weights and concentrations are known to better than 10%, except for zircon in the gabbro whose weights were at, or below, the limit of resolution of the balance
[c] Th/U model ratio inferred from ^{208}Pb/^{206}Pb ratio and age of sample
[d] Total common Pb in sample (initial+blank)
[e] Raw data corrected for fractionation and spike
[f] Corrected for fractionation, spike, blank and initial common Pb
[g] Values indicate the last significant digits of the errors, which are calculated by propagating the main sources of uncertainty
[h] Uncertainty of ^{207}Pb/^{206}Pb age

vatn in the more easterly portions of the unit (Fig. 2). The rock is essentially massive, and plagioclase still defines a crude ophitic texture but the mafic minerals are generally retrogressed to green amphibole and chlorite. The gabbro yielded very little zircon, mainly fragments and some rare whole crystals, and most of these were turbid and unsuitable for analysis. By intensive abrasion of the best-preserved fragments, it was nevertheless possible to recover some reasonably clear grains more or less free of turbid domains. The four analyses done on three single grains and a two-grain fraction yield somewhat discordant but clustered data points which do not define a single discordia line. The three least-discordant analyses fit very well on a line projected from 925±50 Ma, the approximate time of metamorphism indicated by the monzonite data, yielding an upper intercept age of 1,464±6 Ma. This age is taken as the best estimate for the age of intrusion of the gabbro, and the trajectory of the line is attributed to Pb loss during the Sveconorwegian event. The fourth and most discordant analysis deviated from this line, suggesting that this zircon underwent secondary Pb loss, probably linked to the fact that this grain still retained a turbid spot after abrasion.

Discussion

Links of the Dalsfjord suite to other basement complexes

The age of 1,634±3 Ma places the Dalsfjord monzonite in the context of a major orogenic period (Gothian) which built much of the continental crust now exposed in a domain stretching from southern Sweden to the WGR in western Norway (Gaál and Gorbatchev 1987; Tucker et al. 1987, 1990; Skår et al. 1994; Christoffel et al. 1999; Åhäll and Larson 2000). In the WGR, a magmatic arc was formed between about 1,690 and 1,630 Ma, presumably outboard of the pre-existing continental crust, and apparently growing progressively towards the south (e.g., Tucker et al. 1987, 1990; Skår 1998; Austrheim et al. 2002). Gothian ages also characterize the dated portions of the Jotun Complex, as indicated by zircon upper intercept ages of 1,694±20 and 1,666+26/–23 Ma (Schärer 1980). Comparable Rb–Sr whole-rock ages have also been reported for the crystalline segments of the Hardangervidda-Ryfylke Nappe Complex to the southwest of the Jotun Nappe Complex (Fig. 1; Gabrielsen et al. 1979).

Conversely, the 1,464±6 Ma intrusion age of the gabbro in the Dalsfjord Complex corresponds to an event of mafic magmatism which was widespread throughout Baltica and Laurentia (e.g., Åhäll and Connelly 1998). In western Norway mafic bodies of approximately this age can be found both in the WGR (e.g., the Selnes gabbro; Tucker et al. 1990), and in the Jotun Complex (Leirungsmyran gabbro; Corfu and Emmett 1992).

Because of the presence of rocks of this age in the basement as well as in the Middle Allochthon, the 1,634-Ma monzonite and 1,464-Ma gabbro ages of the Dalsfjord Complex are of limited diagnostic value in discussing the provenance of the Middle Allochthon, even though they are consistent with a correlation between the Jotun and the Dalsfjord complexes.

What is more significant is, instead, the combination of these primary ages with the strong metamorphic overprint during the Sveconorwegian orogeny, especially that recorded by the monzonite zircons. A similar effect on the discordance of zircon and titanite fractions is entirely missing in units of the northern WGR (Tucker et al. 1987, 1990; Austrheim et al. 2002), and seems to be much less pronounced in rocks of the southern domains of the WGR where late Sveconorwegian events caused local anatexis and the intrusion of granitic bodies (Gromet and Andersen 1994; Skår 1998). An example for this distinction between allochthon and basement is provided by the zircon U–Pb systematics of a quartz diorite in the ‘Askvoll Group’, a highly mylonitic composite succession of rocks which occurs within the NSDZ below the Dalsfjord Complex (Swensson and Andersen 1991). The quartz-diorite zircons yield an age of 1,641±2 Ma (Skår et al. 1994) which is nearly identical to the 1,634±3 Ma age of the Dalsfjord monzonite, but in this case the discordia line projects towards a Paleozoic lower intercept age without any evidence of having been affected by Sveconorwegian Pb loss. By contrast, strongly discordant zircon analyses indicative of substantial Sveconorwegian Pb loss are the most typical characteristic of the Jotun gneisses investigated by Schärer (1980). The favorable comparison between the Dalsfjord and Jotun complexes is also strengthened by the very late timing of Sveconorwegian deformation and metamorphism implied by the 920–880 Ma zircon lower intercept and metamorphic titanite ages. Such a late Sveconorwegian activity was not a common feature of the upper crust in the Sveconorwegian orogen, which in this region underwent local anatexis at about 970–950 Ma and was intruded by post-tectonic granites at about 950–930 Ma (Corfu 1980; Tucker et al. 1990; Skår 2000). The genesis of these granites coincides with the intrusion of anorthositic complexes in the Rogaland area of southernmost Norway (Schärer et al. 1996) and the associated thermal metamorphism (Bingen and van Breemen 1998), features indicative of extensive mantle-crust interaction with lower crustal melting.

The contrasting isotopic behavior, and the locally strong deformational and metamorphic overprint recorded by the Jotun-Dalsfjord rocks suggest that, if the system was once part of Baltica, it likely was situated in the lower crustal levels of the orogen. The late Sveconorwegian metamorphism which affected these units could possibly be related to late orogenic extension and mantle upwelling connected to some delamination mechanism. A similar extensional mechanism could account for the subsequent exhumation which brought these units to the surface to allow basin formation and sedimentation of the Neoproterozoic (to Early Paleozoic?) Valdres Sparagmite on the Jotun Complex, and the Høvik Group on the Dalsfjord Complex.

The Lindås Nappe in the Bergen Arcs records late Sveconorwegian deformation and granulite facies metamorphism dated at about 930 Ma (Bingen et al. 2001), and thus in a time frame broadly comparable to that of the Jotun and Dalsfjord complexes. A peculiarity of the Lindås Nappe, however, is the fact that the formation of the protoliths of the high-grade complex of mangerites and anorthosites was apparently restricted to the period between ca. 1,240 and 950 Ma (Bingen et al. 2001), with as yet no evidence for the presence of a Gothian intrusive complex such as those of the Jotun and Dalsfjord suites.

Only more detailed work could tell whether this disparity is just an anomaly related to insufficient geochronological coverage or whether it indicates a significant distinction in the provenance of these terranes.

Caledonian events

The Høyvik Group and Valdres Sparagmite sedimentary rocks have been interpreted to be part of the Late Precambrian passive margin sequence of Baltica, and their lithological similarity also supports the proposed identity between the two nappes. The Høyvik Group was deformed at greenschist facies conditions, exhumed and unconformably overlain by the fossiliferous Silurian Herland Group (Wenlock). White phengitic mica from the Høyvik Group yields $^{40}Ar/^{39}Ar$ ages of ca. 447 Ma, a minimum age for the metamorphism and deformation of the Høyvik Group (Andersen et al. 1998; Eide et al. 1999) which preceded its exhumation and the unconformable deposition of the Silurian (Wenlock) sedimentary rocks (Brekke and Solberg 1987). Because of the temporal constraints, this Ordovician orogenic phase must have predated the Scandian collisional phase of the orogeny, reflecting instead a regional phase of subduction or collision at the margin of Iapetus.

On the basis of the proposed correlation of the Høvik Group with the Valdres Sparagmite, one would expect to find evidence for the Middle Ordovician tectono-metamorphic event in the latter successions, but this is not the case. Rocks of the Valdres area only record the shortening related to Scandian nappe formation and its overprint by the west-vergent structures related to late orogenic extension (Andersen 1998), and various dating techniques only yield Late Silurian and Devonian ages linked to these two events (Schärer 1980; Fossen and Dunlap 1998). The Lower to Middle Ordovician sedimentary record in the Valdres area, however, indicates a marked influx of flysch-type sediments after Llanvirn (Nickelsen et al. 1985). Along the northeastern margin of the Jotun Nappe Complex, Sturt and Ramsay (1999) have described stratigraphic evidence of a pre-Llanvirn (base Llanvirn 470 Ma) deformation affecting the Heidal Group, which is normally correlated with the Late Proterozoic sparagmites. A psammitic sedimentary sequence correlative, at least in term of depositional age, to the Høyvik and Valdres units may also be present in the Bergen Arcs (Fossen 1988).

The Lindås Nappe itself has a complex and still not quite well-understood record for the Caledonian activity. Although there is a general agreement on the timing of the major Middle to Late Silurian metamorphic and deformation event also associated with felsic magmatism (e.g., Kühn et al. 2002), an intense debate remains concerning the existence of an Early-Middle Ordovician event as suggested by apparent $^{40}Ar/^{39}Ar$ and U–Pb ages on various minerals (Boundy et al. 1996, 1997; Bingen et al. 2001). The correlation of the Lindås Nappe with the Dalsfjord and Jotun nappes is not without problems, in part because the former contains Caledonian eclogites indicating that this slice of continental crust was subducted to great depth during the Caledonian orogeny (e.g., Austrheim and Griffin 1985; Bingen et al. 2001), whereas the Jotun and Dalsfjord Nappes contain no known eclogites. This disparity is generally taken to indicate that these nappes represent different portions of a common crustal unit (generally set at the outer edge of Baltica) which were depressed at different depths during Caledonian events (Milnes et al. 1997).

Concluding remarks

The new U–Pb zircon ages of 1,634±3 Ma and 1,464± 6 Ma for monzonite and gabbro, respectively, and the Late Sveconorwegian titanite ages in the monzonite provide strong support to the notion that the Dalsfjord magmatic suite is correlative in time as well as tectonic position with the petrologically similar rocks of the Jotun Nappe Complex. The isotopic information is consistent with the previously noticed lithological affinity of the magmatic suites, the fact that both have a cover of comparable Late Precambrian (to Early Paleozoic) psammitic rocks suggesting a derivation of the nappes from the continental margin of Baltica, and the fact that both units occur in a very similar tectonic position with respect to the surrounding allochthonous units. On a regional scale, however, there remain many other details which are poorly understood and in need of more intense study in order to achieve a more comprehensive overview of the tectonic relationships and provenance of the various allochthonous segments.

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