Polarforschung 68: 171 - 178, 1998 (erschienen 2000)

The Tectono-Magmatic Evolution of the Taimyr Peninsula: Further Constraints from New Ion-Microprobe Data

By Victoria Pease[1] and Valerij Vernikovsky[2]

THEME 8: Polar Urals, Novaja Semlja and Taimyr: The Northern Connection of the Uralides

Summary: We present the initial results of a U-Th-Pb zircon ion-microprobe investigation on samples from the Central Belt of Taimyr, in order to constrain its tectono-magmatic evolution. The zircon samples are from a deformed two-mica granite (Faddey Massif), deformed metamorphosed gabbroic dike entrained as pods and lenses within metamorphosed tholeiitic basalts of the Kunar-Mod volcanic suite (Klyaz'ma River region), a metamorphosed rhyolite of the same volcanic suite overlying the basic metavolcanic rocks, as well as an undeformed dolerite dike which intrudes the metamorphosed Kunar-Mod basic volcanic rocks.

Preliminary results on zircons from the two-mica granite suggest a crystallization age of ~630 Ma for this rock, with inheritance from assimilated crust 840 Ma to 1.1 Ga in age. In the Klyaz'ma River region, zircons from the meta-rhyolite yield a concordant age of ~630 Ma. Zircons from the entrained metagabbroic dikes have so far yielded an age of ~615 Ma (1 grain), as well as Archean ages (5 grains, concordant at 2.6-2.8 Ga). It seems likely that the Archean grains represent assimilation of older crustal material. Zircons from the post-tectonic dolerite dike have a bimodal age distribution. A well-defined younger age of 281 ±9 Ma is interpreted to represent the crystallization age of the dike, while older, concordant ages of 2.6-2.9 Ga likely represent assimilation of Archean crust (Siberian craton at depth).

Several important conclusions can be drawn from the data. (1) The mafic and felsic lithologies of the Kunar-Mod volcanic suite are genetically related and should be the same age. Ages of ~630 Ma (meta-rhyolite) and ~615 Ma (metagabbroic dikes representing the latest stage of mafic magmatism associated the Kunar-Mod suite) suggest that these lithologies may be the same age, but more data are required to confirm this hypothesis. (2) The 630 Ma two-mica granite is similar in age to the time of high-grade metamorphism, suggesting that syntectonic granite emplacement accompanied obduction of the accretionary Central Belt to the Siberian craton. (3) An Early Permian age is well defined for the undeformed dolerite dike. Dolerite dikes occur across the whole of Taimyr, but are deformed to the south. If related, this single magmatic event pre-dates Permo-Triassic Siberian trap magmatism. Furthermore, it suggests that deformation was localized to southeastern Taimyr.

INTRODUCTION

The Taimyr Peninsula holds an enigmatic position in the Arctic region (Fig. 1). Many authors have suggested that the continuation of the Uralian orogen is manifest in Taimyr (e.g. HAMILTON 1970, ZONENSHAIN et al. 1990, SENGÖR et. al. 1993, PUCHKOV 1997); however, Paleozoic ophiolites, blueschists and eclogites, and thrust faults dipping towards the Siberian craton, elements typical of the Uralian orogen (cf. PUCHKOV 1997), are apparently absent from Taimyr. The apparent absence of Paleozoic oceanic remnants may, however, reflect the paucity of modern isotopic data from Taimyr, which also makes the interpretation of the tectonic evolution of the region somewhat speculative. Published K-Ar data from magmatic and metamorphic complexes generally define ages of 225-280 Ma, reflecting thermal processes associated with Late Paleozoic orogeny and Early Mesozoic trap magmatism (ZAKHAROV et al. 1977). Only limited modern U-Pb isotopic age determinations have been made (e.g. ZAKHAROV et al. 1993, VERNIKOVSKY et al. 1998a, VERNIKOVSKY et al. 1998b). Consequently, in order to evaluate the higher-temperature magmatic and tectonic history of the region, there is an urgent need for more U-Pb isotopic data.

We present initial results from an ion-microprobe U-Th-Pb zircon investigation of five samples from the Central Belt of Taimyr and discuss the tectono-magmatic ramifications of these results. Previous studies indicate that zircon populations in rocks from the Central Belt of Taimyr comprise multiple age populations (VERNIKOVSKY et al. 1994, 1997, 1998). High spatial-resolution (30 µm), high-sensitivity ion-microprobe analysis is particularly suited to these rocks because we can (i) determine magmatic ages where conventional techniques lack resolution due to the presence of inherited components, (ii) determine magmatic ages for samples with low zircon yield, and (iii) identify polyphase metamorphic events. These results are part of a larger research program, in which we hope to contribute significantly to the geochronological understanding of Taimyr.

GEOLOGIC BACKGROUND AND PREVIOUS WORK

Three structural/lithologic domains, thought to be divided by major south-verging thrust faults, are recognized in Taimyr (UFLYAND et al. 1991) and are herein referred to as the North, Central, and Southern Belts. The Southern Belt, south of the Central Belt (Fig. 1), is a Paleozoic-Mesozoic fold and thrust belt. It is a succession of unmetamorphosed Ordovician to Permian carbonates and marine clastic sediments and Late Permian to Early Triassic volcanogenic sediments representing the platform successions of the Siberian craton.

[1] Uppsala University, Department of Earth Sciences, Villavägen 16, SE-752 36 Uppsala, Sweden, <vicky.pease@nrm.se>
[2] United Institute of Geology, Geophysics, and Mineralogy, Siberian Branch, Russian Academy of Sciences, Koptyug Ave. 3, 630090 Novosibirsk, Russia, <taimyr@uiggm.nsc.ru>

Manuscript received 27 November 1998, accepted 30 May 1999

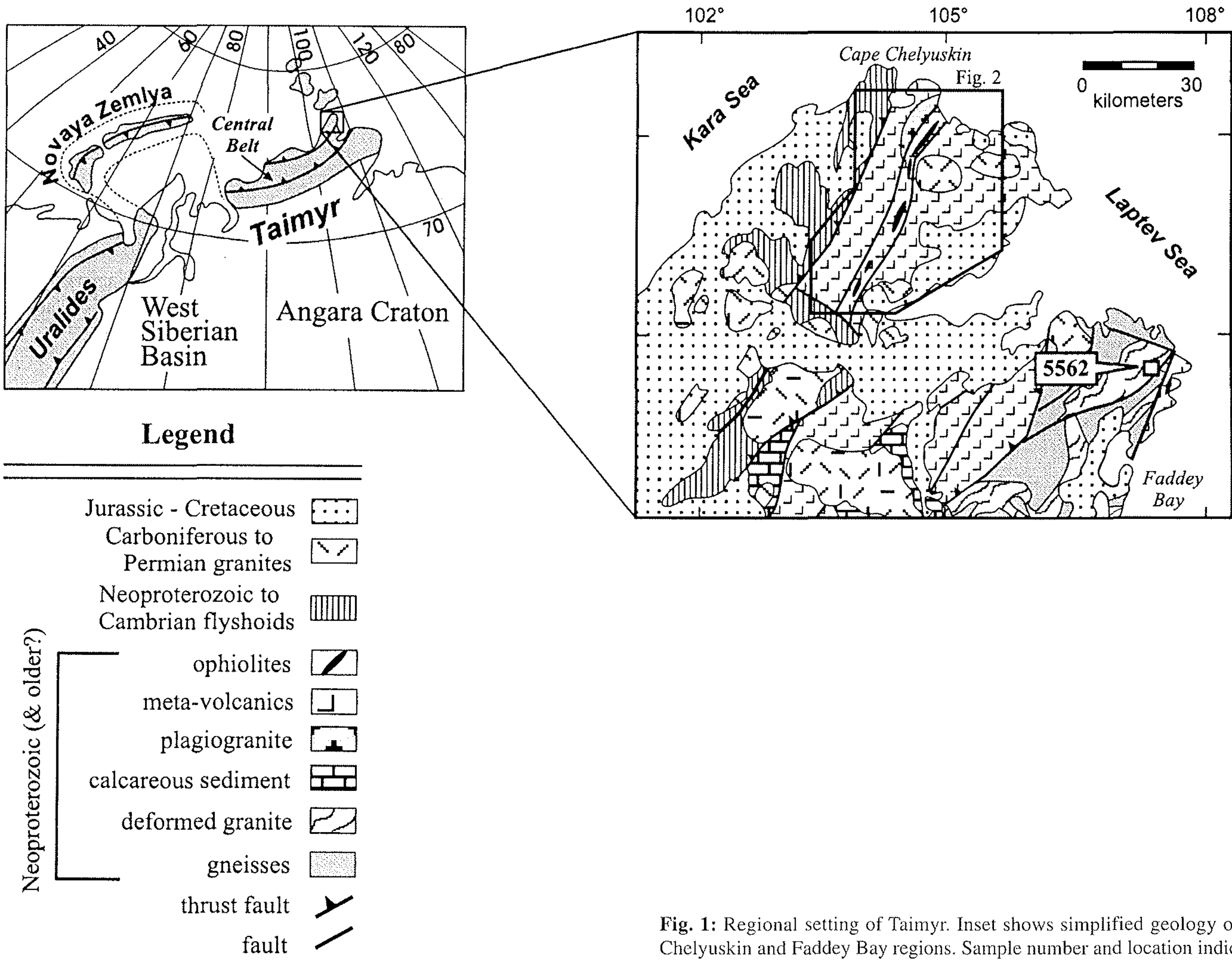


Fig. 1: Regional setting of Taimyr. Inset shows simplified geology of Cape Chelyuskin and Faddey Bay regions. Sample number and location indicated.

The Northern Belt, north of the Central Belt (Fig. 1), is dominated by rhythmically interbedded Neoproterozoic sandstones, siltstones, and pelites. These sediments are interpreted to represent turbidites formed on the continental slope/foot of an allochthonous terrane known as the Kara block, and their Riphean age is known from acritarchs. Late Paleozoic deformation resulted in regional greenschist and amphibolite facies metamorphism of the Kara block under moderate pressure conditions. Thermobarometry suggests that temperatures associated with garnet to sillimanite grade metamorphism vary from 460 to 650 °C, at pressures of 3-6.5 kbar (VERNIKOVSKY 1995). The rocks are extensively migmatized and intruded by syn- and post-tectonic Carboniferous-Permian granites (VERNIKOVSKY et al. 1995, VERNIKOVSKY et al. 1998b).

The Central Belt (Fig. 1) is structurally and lithologically diverse. Pre-Neoproterozoic (?) and Neoproterozoic sedimentary, volcanogenic, and intrusive complexes of various ages, differing metamorphic grades and degrees of hydrothermal metasomatism, are thought to represent ophiolites, island-arc and back-arc complexes, and continental fragments. Thus the Central Belt is regarded as an accretionary terrane (ZONENSHAIN & NATAPOV 1987, ZONENSHAIN et al. 1990, UFLYAND et al. 1991). Wide spread, high-grade metamorphism occurred in the Central Belt at about 600 Ma (VERNIKOVSKY 1995). Unmetamorphosed Vendian to Early Carboniferous sediments unconformably overlay the metamorphosed basement. Consequently, accretion of the Central Belt to the Siberian craton must have occurred prior to depostion of the Vendian and younger sediments, and the age of metamorphism associated with the Central Belt may reflect the time of this accretionary event (VERNIKOVSKY 1995).

The tectonic evolution of the Central Belt is constrained by sparse modern isotopic (Tab. 1) and P/T data. Continental crustal fragments of high-grade (epidote-amphibolite and amphibolite facies) gneisses, schists, autochthonous and para-autochthonous granites, granitic-gneisses, and migmatites are found in the region near Faddey Bay (Fig. 1) and between the Mamont and Shrenk rivers (approx. 300 km west of Fig. 1). These two gneiss terranes are correlated on the basis of metamorphic grade and mineralogy, metapelite geochemistry, and geochronology (VERNIKOVSKY 1995). Thermobarometry on samples from the gneiss region of Faddey Bay suggests metamorphic conditions of 600-700 °C and 6-9 kbar (VERNIKOVSKY 1995).

The Zhdanov Massif, a deformed granite intruding the Faddey Bay gneiss region (approx. 20 km south of Fig. 1), has been dated by conventional U-Pb zircon analysis, yielding discordant ages which define a poorly constrained lower intercept with a

Separate	Method	Age (Ma)	Interpretation	Reference
Faddey gneiss terrane, Zhdanov granite				
wr	Sm-Nd_{TDM}	1796-1902	age of crust	VERNIKOVSKY et al. (1998)
z	U-Pb	846 ± 11	age of crystallization	
z	U-Pb	612 ± 43	lower intercept	ZAKHAROV et al. (1993)
sp	U-Pb	817 ± 30	age of crystallization	
m	K-Ar	803 ± 23	age of crystallization	
m	K-Ar	813 ± 26	age of crystallization	
wr	Rb-Sr isochron	763 ± 12	time of metamorphism	MAKHLAEV et al. (1992)
Chelyuskin ophilolite belt, Kunar plagiogranite				
wr	Sm-Nd_{TDM}	785-850	age of crust	VERNIKOVSKY et al. (1994)
z	U-Pb	740 ± 38	age of crystallization	
wr	Rb-Sr isochron	727 ± 83	age of crystallization	
Stanovoy ophiolite belt, garnet amphibolite				
g,b,a,wr	Sm-Nd isochron	573 ± 78	age of metamorphism	VERNIKOVSKY et al. (1997)
g,b,p,a,wr	Rb-Sr isochron	606 ± 44	age of metamorphism	
b	Ar-Ar	624 ± 16	age of metamorphism	
b	K-Ar	596 ± 6	age of metamorphism	
a	K-Ar	626 ± 6	age of metamorphism	

Tab. 1: Summary of isotopic ages from the Central Belt of Taimyr. Notes: wr - whole rock; z - zircon; b - biotite; a – amphibole; g – garnet; m – muscovite; p . plagioclase feldspar; sp – sphene.

minimum age of 560 Ma and a maximum age of 850 Ma (Tab. 1). The least radiogenic size-fraction, however, has nearly concordant $^{207}Pb/^{206}Pb$ and $^{206}Pb/^{238}U$ ages suggesting that 848 ±11 Ma may be the best approximation for the age of this granite (VERNIKOVSKY et al. 1998). Sm-Nd model ages of 1.8-1.9 Ga suggest that Early Proterozoic crust was involved in the genesis of this granite (VERNIKOVSKY et al. 1998).

A deformed granite intruding the Mamont-Shrenk gneiss region, dated by conventional U-Pb (zircon and sphene) techniques, yielded discordant zircon ages with a poorly defined lower intercept of 612 ±43 Ma and an upper intercept of 1869 ±56 Ma, while an age of 817 ±30 Ma was obtained from sphene, and other ages (K-Ar, muscovite) include 803 ±23 Ma and 813 ±26 Ma (ZAKHAROV et al. 1993). The age of metamorphism in the gneissic country rock of the granite is 763 ±12 Ma (Rb-Sr isochron, MAKHLAEV et al. 1992). Consequently, the crystallization age of this granite is not well constrained with the present data.

Fragments of ophiolites are found throughout the Central Belt, most notably in the Cape Chelyuskin and Faddey Bay regions (Fig. 1), known respectively as the Chelyuskin and Stanovoy ophiolite belts (VERNIKOVSKY 1995). A conventional U-Pb zircon analysis of plagiogranite from the Chelyuskin ophiolite belt yielded discordant ages with a poorly constrained lower intercept of 673 ±136 Ma. The least radiogenic size-fraction has nearly concordant $^{207}Pb/^{206}Pb$ and $^{206}Pb/^{238}U$ ages, however, suggesting that 740 ±38 Ma may best approximate the age of the plagiogranite (VERNIKOVSKY et al. 1994).

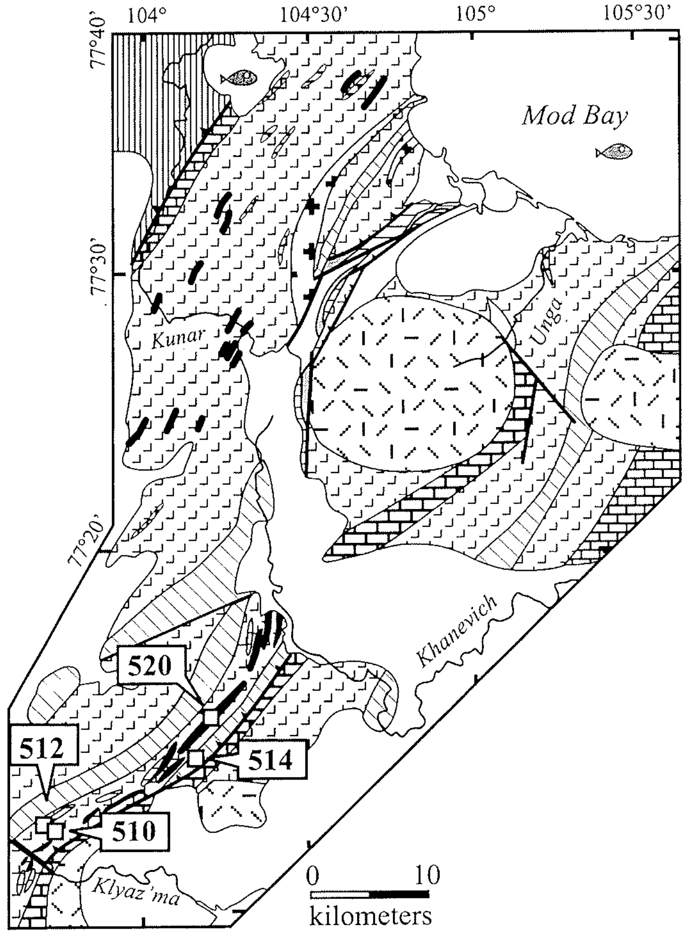
There are no U-Pb ages for volcanic arc lithologies from the Central Belt; first-order age relationships are based on stratigraphy (BEZZUBTSEV et al. 1986) and geologic association. The Kunar-Mod volcanic suite, best exposed in the Kunar river and to the north near Mod Bay (Fig. 1), comprises metamorphosed tholeiitic basalts, andestites, and rhyolites. Based on geochemistry, this suite is interpreted to have formed as an island arc in a marginal sea basin as the result of ocean-ocean collision (VERNIKOVSKY et al. 1996). The Kunar-Mod suite is host to generally sub-parallel gabbroic dikes and sills, all metamorphosed under greenschist facies conditions.

ANALYTICAL TECHNIQUES

Zircons were separated using standard pre-concentration procedures. Grains were hand-picked under a binocular microscope and then mounted in transparent epoxy, together with a reference zircon (1065 Ma Geostandards 91500). Ion-microprobe analyses were performed at the Nordsim facility (Stockholm, Sweden), using a high-mass resolution, high-sensitivity Cameca IMS 1270. Instrument parameters, analytical procedures, and U/Pb calibration method are similar to those outlined by WHITEHOUSE et al. (1997a, 1997b). ^{204}Pb was corrected for common Pb according to the procedure outlined by WHITEHOUSE et al. (1997a).

RESULTS AND DISCUSSION

Sample locations are shown in Figures 1 and 2. Ion-microprobe analytical data and derived parameters for the five samples are presented in Table 2. Cathodoluminesence (CL) images of zircon grains are presented in Figure 3, with the position of the ion-beam indicated by the oval. The exact ion-beam location was determined using a scanning electron microprobe (SEM) after ion-microprobe analysis. Tera-Wasserburg concordia diagrams ($^{207}Pb/^{206}Pb$ *vs.* $^{238}U/^{206}Pb$) for samples 514, 520, and 5562 are shown in Figure 4. The majority of analyses yielded concordant or nearly concordant U-Pb ages. Discordant data points may be explained by modern-day (zero age) Pb loss, as indicated by a horizontal shift of data points to the right in Tera-Wasserburg diagrams, by ancient Pb loss, or by some combination of the two.



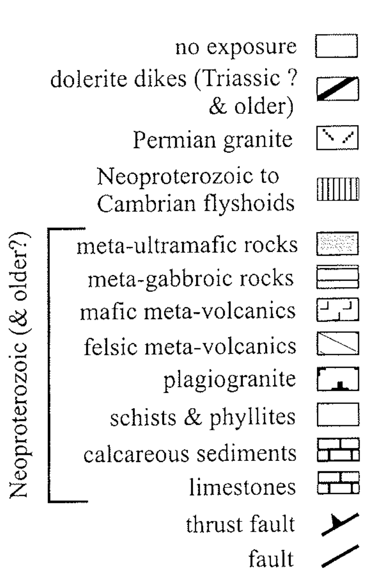


Fig. 2: Simplified geology of the Mod Bay region of Cape Chelyuskin. Sample numbers and locations indicated.

Metagabbros (samples 510 & 512)

These metamorphosed gabbroic dikes intrude the metabasic lithologies of the Kunar-Mod volcanic suite (Fig. 2). The samples had extremely low zircon yield. Only four grains were obtained from sample 510 and only two grains from sample 512. The grains from 510 show diverse morphologies (Fig. 3) and represent typically igneous grains (pink, euhedral, acicular grains with aspect ratios of 4:1, concentric crystallographic zoning, e.g. grain 1), as well as those suggesting a resorbtion event (clear, small sub-rounded grains with 1:1 aspect ratios, bright rims which truncate crystallographic zoning in cores, e.g. grain 3). The two grains from 512 (Fig. 3) were small (30 x 30 μm), sub-rounded, and showed minor zoning.

All zircons from sample 510 and one zircon from 512 yielded Archean ages of ca. 2600-2985 Ma (Tab. 2). Only one grain from sample 512 gave a Neoproterozoic age of ~615 Ma. In spite of the paucity of analyzed grains from these samples, the consistent generation of concordant Archean ages suggests that these dikes are either Archean in age or have had notable interaction with pre-existing Archean crust or sediments derived from Archean crust. The $^{206}Pb/^{238}U$ age of ~615 Ma from sample 512 suggests that the latter is more likely the age of crystallization and the older grains represent an inherited crustal component.

Metarhyolite (sample 514)

This metarhyolite represents the felsic part of the Kunar-Mod volcanic suite (Fig. 2). Euhedral zircons, pale yellow and acicular, with grain sizes varying from 30 x 60 μm to 60 x 120 μm, are typical. Some cores contain non-opaque inclusions. Concentric crystallographic zoning is visible in both plane light and in CL images - because these zircons have relatively uniform morphologies and analytical results, a single representative grain is shown (Fig. 3).

The analytical results for this sample are generally concordant (Fig. 4a). Weighted mean ages, both $^{206}Pb/^{238}U$ and $^{207}Pb/^{206}Pb$, are statistically inditinguishable at 627 ±7 Ma and 627 ±15 Ma, respectively. The age of 627 Ma is taken to be the age of crystallization for this rhyolite.

Dolerite dike (sample 520)

Undeformed dolerite dikes intrude at moderate to high angles the basic metavolcanic rocks of the Kunar-Mod series (which also hosts the metagabbro samples) in the northeast region of the Central Belt (Fig. 2). They are sometimes parallel to the regional structures and sometimes cross-cut it. Zircon separates from this sample have two distinct morphologies (Fig. 3): 1) clear, acicular (40 x 150 μm), euhedral, inclusion-free grains with good igneous zoning visible in CL, e.g. grain 4; 2) light pink, stubby grains (30 x 30 μm) in which zoned cores are truncated by rim overgrowths, e.g. grain 3.

Sample (grain.spot)	U ppm	Pb ppm	Th ppm	Th/U	f_{206} %	$^{207}Pb/^{206}Pb$	± 1σ	$^{206}Pb/^{238}U$	± 1σ	Age estimates (Ma) $^{207}Pb/^{206}Pb$		Age estimates (Ma) $^{206}Pb/^{238}U$		Disc %
510 (metagabbro)														
1.1	234	152	84	0.272	0.70	0.18334	0.41	0.50448	1.49	2683	± 7	2633	± 32	0
2.1	399	314	181	0.490	0.04	0.20793	0.23	0.58895	1.46	2889	± 4	2985	± 35	1
3.1	303	188	70	0.237	0.12	0.17864	0.32	0.49700	1.43	2640	± 5	2601	± 31	0
4.1	370	362	12	(-0.05)	20.87	0.20130	2.90	0.55826	1.75	2837	± 47	2859	± 40	0
512 (metagabbro)														
1.1	287	201	85	0.333	0.32	0.18884	0.36	0.54579	1.43	2732	± 6	2808	± 33	0
2.1	264	44	164	(1.401)	16.42	0.05094	17.21	0.10012	1.99	(238	± 404)	615	± 12	176
514 (metarhyolite)														
1.1	326	43	159	0.546	-	0.05875	0.86	0.10980	2.18	(558	± 19)	(672	± 14)	16
2.1	289	37	156	0.497	-	0.06036	1.18	0.10422	1.88	617	± 25	639	± 11	0
3.1	561	75	393	0.682	0.49	0.05982	1.20	0.10487	1.45	597	± 26	643	± 9	5
4.1	381	47	167	0.413	-	0.06169	0.84	0.10183	0.57	663	± 18	625	± 3	-5
5.1	182	23	108	0.558	-	0.06105	1.63	0.10029	0.61	641	± 35	616	± 4	-3
6.1	427	53	212	0.467	-	0.06076	0.80	0.10168	0.57	631	± 17	624	± 3	0
7.1	416	51	168	0.492	0.38	0.05853	1.13	0.10141	0.90	(550	± 25)	623	± 5	12
8.1	461	58	230	0.526	-	0.06017	0.82	0.10435	0.59	610	± 18	640	± 4	4
9.1	475	58	210	0.448	-	0.06052	0.82	0.10207	0.56	622	± 18	627	± 3	0
520 (diabase dike)														
1.1c	253	30	186	(0.107)	-	0.23270	4.96	0.06238	3.11	3071	± 79	390	± 12	-89
2.1c	137	7	21	(0.063)	-	0.05390	1.86	0.04547	1.99	367	± 42	287	± 6	-19
3.1c	528	465	571	1.141	0.10	0.20408	0.22	0.58664	1.44	(2859	± 4)	(2976	± 34)	2
4.1m	252	15	190	0.563	-	0.05219	1.40	0.04737	1.74	294	± 32	298	± 5	0
5.1c	80	49	50	0.554	3.21	0.14661	1.47	0.44560	1.99	(2307	± 25)	(2376	± 39)	0
6.1m	454	28	375	(0.186)	-	0.07929	1.11	0.04369	1.62	1179	± 22	276	± 4	-78
7.1c	277	16	213	0.510	-	0.05521	1.77	0.04511	0.64	421	± 40	284	± 2	-32
8.1c	217	12	135	0.683	-	0.05117	2.04	0.04469	0.76	248	± 47	282	± 2	12
9.1m	206	12	133	(0.281)	-	0.06036	2.26	0.04447	0.61	617	± 49	280	± 2	-55
5562 (2-mica granite)														
1.1c	620	120	404	0.556	1.02	0.06760	1.19	0.15516	1.68	856	± 25	930	± 15	6
2.1c	376	77	197	(0.374)	1.00	0.07534	1.74	0.16809	1.46	1078	± 35	1002	± 14	-5
3.1c	307	59	129	0.419	-	0.06954	1.03	0.16114	1.57	915	± 21	963	± 14	2
4.1m	869	166	568	0.592	2.38	0.06743	2.86	0.14622	1.76	851	± 60	880	± 15	0
5.1c	1032	178	947	(0.309)	12.44	0.06436	4.33	0.11436	0.62	753	± 93	698	± 4	-7
5.2m	2263	380	5496	(0.424)	41.02	0.06334	8.44	0.07139	0.85	(720	± 180)	(445	± 4)	-39
6.1c	334	64	182	0.559	0.39	0.06736	1.33	0.15547	0.64	849	± 28	932	± 6	9
7.1c	527	104	353	0.669	1.67	0.06607	1.17	0.15281	0.55	809	± 25	917	± 5	13
8.1c	484	85	633	(0.874)	13.85	0.06102	10.86	0.10468	0.98	(640	± 235)	642	± 6	0
9.1c	475	58	210	0.448	-	0.06052	0.82	0.10207	0.56	622	± 18	627	± 3	0
10.1m	546	98	404	0.419	3.43	0.06928	1.63	0.13747	0.58	907	± 34	830	± 5	-8
11.1c	894	169	396	0.300	7.21	0.06784	3.75	0.13872	0.61	864	± 78	837	± 5	-2

Tab. 2: U-Pb ion-microprobe analytical data.
Analyses were performed on a high-mass resolution, high-sensitivity Cameca IMS 1270 ion-microprobe at the NORDSIM facility in Stockholm, Sweden, using previously described analytical techniques (WHITEHOUSE et al. 1997a, 1997b). Analyses from cores denoted by "c" and from mixed zones or rims by "m". Data are reported at 1σ. Errors in age estimates are quoted at 1σ. All ages are calculated using the decay constants of STEIGER & JÄGER (1977). Th/U ratios calculated from $^{207}Pb/^{206}Pb$ and $^{208}Pb/^{206}Pb$ ages–ratios in parentheses differ significantly from measured Th and U concentrations. Data reported in parentheses are not included in mean age determinations (see text). Disc. % refers to the degree of discordance at the 2σ error limit between $^{207}Pb/^{206}Pb$ and $^{206}Pb/^{238}U$ ages. Reverse discordance is indicated by positive numbers.

Zircons from the dolerite dike show a bimodal distribution of younger and older ages (Fig. 4b; Tab. 2). A linear regression through the uncorrected (for common Pb) data points of the younger age group, assuming a zero age common Pb composition of STACEY & KRAMERS (1975), yields an intercept age of 281 ±9 Ma. A mean square of weighted deviates (MSWD) of 6.0 reflects some scatter in the data (Fig. 4b). Two older, concordant ages of 2.6 Ga and 2.9 Ga were also obtained. The younger age of 281 ±9 Ma is interpreted to represent the crystallization age of the dike, while older ages probably represent zircon inheritance. Assimilation of lower crustal material (Siberian craton) at depth by the dolerite magma seems a plausible mechanism to explain the presence of Archean zircons in these post-tectonic dikes.

Faddey Massif (sample 5562)

This *deformed* two-mica granite intruded the gneiss terrane of Faddey Bay (Fig. 1). Zircons separated from this sample are

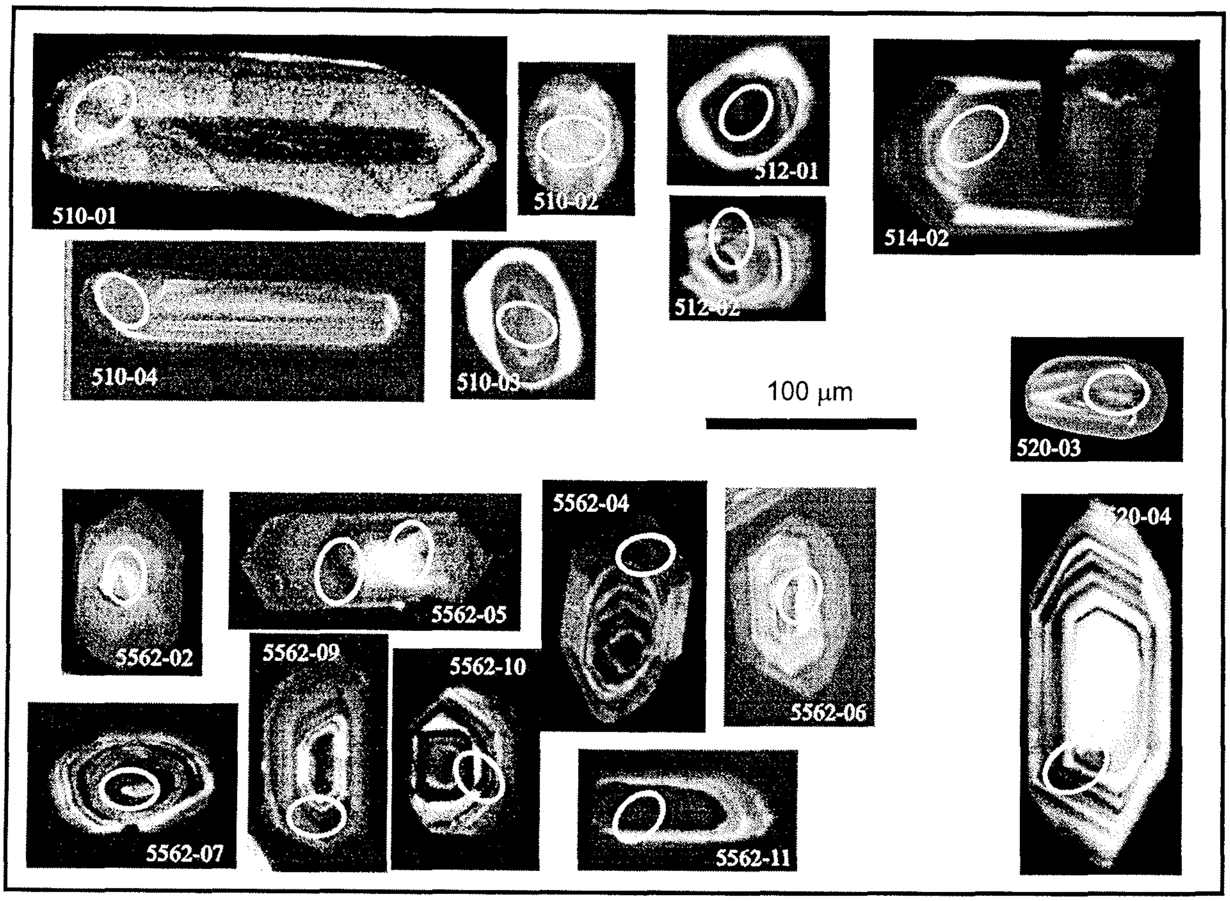


Fig. 3: Representative cathodoluminescence images for all zircon samples. The white oval represents the spot on the grain that the ion-beam analyzed (determined by post-analysis SEM imaging). Spot size is typically 25-30 µm. Compositional zoning in the form of concentric, alternating bright and dark angular bands is generally regarded as igneous in origin, e.g. sample 520-04, whereas amorphous or irregular boundaries may be metamorphic, e.g. the bright rim on 512-01.

uniformly small (30 x 30 µm to 30 x 60 µm) and euhedral. The grains are inclusion-free and light-pink or clear-to-smokey in color. Good crystallographic zoning is visible in plane light and in CL (Fig. 3). CL imaging additionally reveals a rather varied zircon population: Grains with cores truncated by relatively large rim overgrowths (grains 4 & 6), grains with both CL bright cores (grains 6 & 8) and CL dark cores (grains 4 & 11), grains with little zonation (grains 2 & 3), etc.

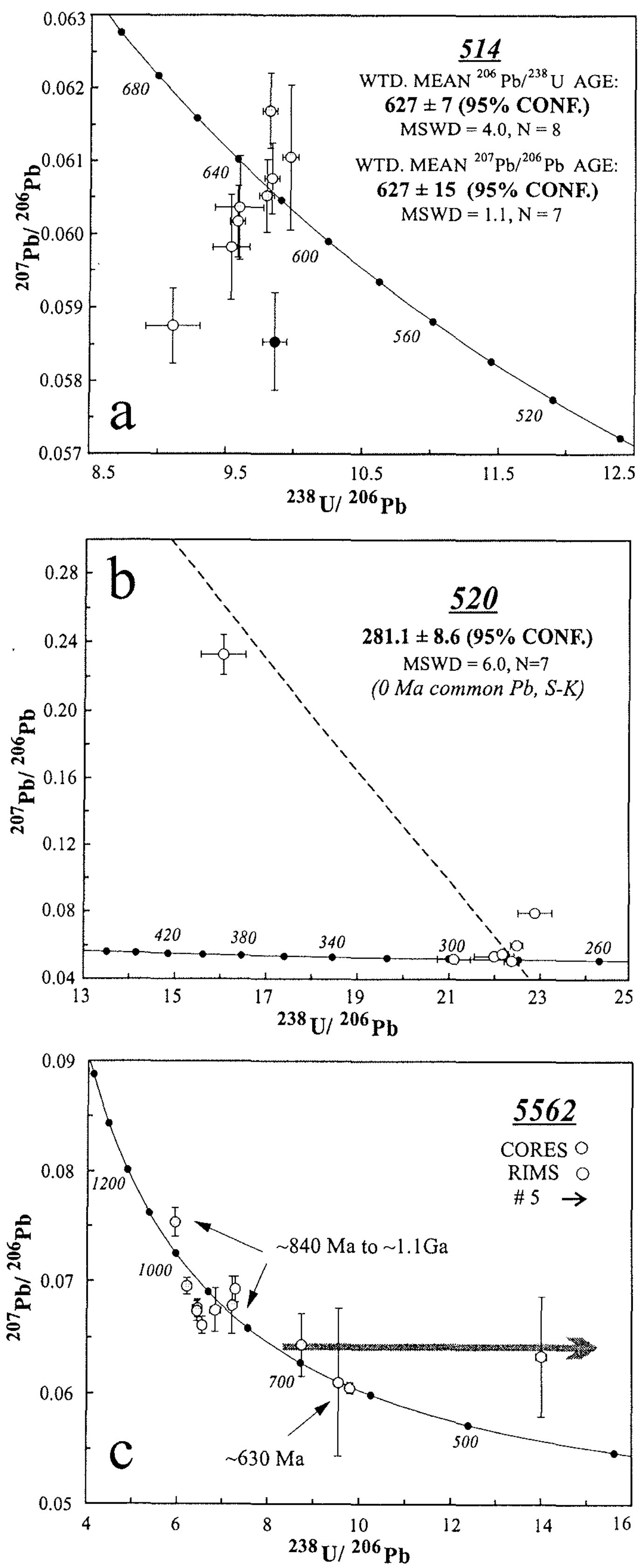
Zircon analysis yielded diverse but concordant (at 2σ) $^{206}Pb/^{238}U$ and $^{207}Pb/^{206}Pb$ ages ranging from ~840 Ma to 1.1 Ga and also grouping at ~630 Ma (Fig. 4c). The horizontal trend between core and rim analyses of grain 5, schematically illustrated by the large arrow in Figure 4c, is compelling evidence for modern Pb loss. Grain 5 has high U and Th contents (>1000 ppm, Tab. 2), suggesting that Pb loss may be due to this high concentration of radioactive elements and consequent lattice damage. Our preliminary interpretation of the zircon data (combined CL images and geochronology) is that the crystallization age of the granite is ~630 Ma and that the older, concordant ages ranging from ~850 Ma to 1.1 Ga represent inherited grains. The origin of inherited zircons by assimilation of a sediment is unlikely because these grains lack the rounding and breakage typical of erosional processes associated with sediment deposition. Rather, it appears that the granite assimilated a somewhat inhomogeneous crust.

SYNOPSIS

In the immediate future our research program includes additional U-Pb geochronology, as well as Sm-Nd and Rb-Sr analyses. Ongoing work will help to establish a detailed geochronological framework for the tectonic evolution of the Central Belt, but even from the limited data presented here several important conclusions can be made:

1) The mafic and felsic lithologies associated with the Kunar-Mod suite are genetically related (Vernikovsky et al. 1996) and should therefore be related in time. The felsic metavolcanic rocks are ~630 Ma old. The metagabbroic dikes, representing the latest stage of mafic magmatism associated with the Kunar-Mod suite, yield a single age of ~615 Ma. Thus preliminary results suggest that these lithologies are close in age, but more data are required to confirm this hypothesis.

It is notable that inherited grains are present only in the mafic lithologies of the Kunar-Mod volcanic suite. This may reflect



differing crustal depths or sources for these magmas, or may be a function of time spent in the melt, i.e.- zircons inherited in a mafic melt which then geochemically evolves into an andesite or ryholite, may be totally resorbed over time. In any case, this also implies that a cratonic source had to be in close proximity to the volcanic arc in order for assimilation to occur. This is difficult to envision if the Kunar-Mod suite represents an oceanic island arc, unless crustal fragments existed in an oceanic environment, e.g. Lomonosov Ridge (JOKAT et al. 1992).

2) The Late Neoproterozoic Faddey Massif is apparently younger than previously dated Middle Proterozoic granites which intrude the Faddey and Mamont-Shrenk gneiss regions, e.g. the Zhdanov Massif and the Mamont-Shrenk granite, respectively. The Faddey Massif has also assimilated Middle Proterozoic crust, whereas the Zhdanov Massif and the Mamont-Shrenk granite indicate significant involvement of Early Proterozoic crustal components. It has been postulated that the Central Belt was obducted at ~600 Ma, the time of high-grade metamorphism. In this context the Faddey Massif is considered syntectonic, suggesting that magmatism and granite genesis was associated with the obduction of the Central Belt.

3) An Early Permian age is well constrained for the undeformed dolerite dike. Mafic magmatism occurs across the whole of the Taimyr Peninsula in the form of dolerite dikes. There is no reason, a priori, to assume that all of these dikes are the same age, though this is regarded as the simplest hypothesis. There are no other U-Pb isotopic data from these dikes, which are folded by post-Jurassic deformation in southeastern Taimyr and are undeformed in the northeastern Central Belt. If these dikes are related to a single magmatic event, it pre-dates Siberian trap magmatism (250 Ma; SHARMA 1997) and suggests that deformation was localized to southeastern Taimyr.

ACKNOWLEDGMENT

This is NORDSIN publication 008.

Fig. 4: Tera-Wasserburg concordia diagrams. All analytical data are plotted with 1s error bars, while all ages are reported at the 95 % confidence level. (a) Sample 514. One data point was excluded from the weighted mean ^{206}Pb/^{238}U age (unfilled circle), while two points were omitted from the weighted mean ^{206}Pb/^{207}Pb age (unfilled circle + black filled circle). (b) Sample 520. All data points (unfilled circles) were used in the linear regression, which is forced through a present-day common lead composition using the model of STACEY & KRAMERS (1975). (c) Sample 5562. Shaded circles represent analyzed zircon cores and unfilled circles, rims. The shaded arrow schematically illustrates modern lead loss between the rim and core of grain 5, and suggests a minimum age (assuming concordance) of ~750 Ma for this grain.

References

Bezzubtsev, V., Zalyaleev, R. & Sakovich, A. (1986): Geological map of the Gorny Taimyr 1:500000 - Explanatory note, Krasnoyarsk, 177 pp (in Russian).

Hamilton, W. (1970): The Uralides and the motion of the Eurasian and Siberian platforms.- Geol. Soc. Am. Bull. 81: 2553-2576.

Jokat, W., Uenzelmann-Neben, G., Kristoffersen, Y. & Rasmussen, T. (1992): Lomonosov Ridge - a double-sided continental margin.- Geology 20: 887-890.

Makhlaev, L., Andreichev, V., Golubeva, I. & Sharkova, V. (1992): Rb-Sr dating of crystalline rocks in the Mamont-Shrenk block, central Taimyr.- Doklady RAN 324: 1265-1269 (in Russian).

Puchkov, V. (1997): Structure and geodynamics of the Uralian orogen.- In: J.-P. BURG & M. FORD (eds.), Orogeny Through Time, Geol. Soc. Spec. Publ. 121: 201-236.

Sengör, A., Natal'in, B. & Burtman, V. (1993): Evolution of the Altaid tectonic collage and Palaeozoic crustal growth in Eurasia- Nature 364: 299-307.

Sharma, M. (1997): Siberian Traps.- In: J. MAHONEY & M. COFFIN (eds.), Large Igneous Provinces: Continental, Oceanic, and Planetary Flood Volcanism, Am. Geophys. Union, Geophys. Monogr. 100: 273-298.

Stacey, J. & Kramers, J. (1975): Approximation of terrestrial lead isotope evolution by a two-stage model- Earth Planet. Sci. Lett. 26: 207-221.

Steiger, R. & Jäger, E. (1977): Subcommission on geochronology. Conventions on the Use of Decay Constants in Geo- and Cosmochronology.- Earth Planet. Sci. Lett. 36: 359-362.

Uflyand, A., Natapov, L., Lopatin, V. & Chernov, C. (1991): To the Taimyr tectonic nature- Geotectonika 6: 76-93 (in Russian).

Vernikovsky, V. (1995): Riphean and Paleozoic metamorphic complexes of the Taimyr foldbelt - Conditions of formation.- Petrology 3: 55-72.

Vernikovsky, V., Vernikovshaya, A., Neimark, L., Proskurnin, V., Chernykh, A. & Safonova, I. (1994): Petrology, geochemistry, and tectonic setting of plagiogranites of the Chelyuskin ophiolite belt- Internat. Geol. Rev. 36: 961-974.

Vernikovsky, V., Neimark, L., Ponomarchuk, V., Vernikovshaya, A., Kireev, A. & Kuz'min, D. (1995): Geochemistry and age of collision granitoids and metamorphites of the Kara microcontinent (northern Taimyr).- Russian Geol. Geophys. 36: 46-60.

Vernikovsky, V., Vernikovskaya, A., Chernykh, A.,& Melgunov, M. (1996): Petrology and geochemistry of Taimyr Riphean ophiolites.- Russian Geol. Geophys. 36: 103-120.

Vernikovsky, V., Kotov, A., Ponomarchuk, V., Sal'inkova, E. Kovach, V. & Travin, A. (1997): Late Riphean-Vendian history in Taimyr: Sm-Nd, Rb-Sr, K-Ar ages of garnet amphibolites of the Stanovoy ophiolite belt.- Doklady RAN 352: 218-221 (in Russian).

Vernikovsky, V., Sal'nikova, E., Kotov., A., Kovach, V. & Yakovleva, S. (1998a): Precambrian granites of the Faddey terrane (North Taimyr): New geochemical and geochronologic (U-Pb, Sm-Md) data.- Doklady RAN 363: 653-657 (in Russian).

Vernikovsky, V., Sal'nikova, E, Kotov. A., Ponomarchuk, V., Kovach, V., Travin, A., Yakovleva, C. & Berezjnaya, N. (1998b): Age of post-collisional granitoids of Northern Taimyr: U-Pb, Sm-Nd, Rb-Sr, and Ar-Ar data.- Doklady RAN 363: 375-378 (in Russian).

Whitehouse, M., Claesson, S., Sunde, T. & Vestin, J. (1997a): Ion-microprobe U-Pb zircon geochronology and correlation of Archaean gneisses from the Lewisian Complex of Gruinard Bay, northwestern Scotland.- Geochim. Cosmochim. Acta 61: 4429-4438.

Whitehouse, M., Bridgwater, D. & Park, R. (1997b): Detrital zircon ages from the Loch Maree Group, Lewisian Complex, NW Scotland: Confirmation of a Paleoproterozoic Laurentia-Fennoscandia connection.- Terra Nova 9: 260-263.

Zakharov, Y., Chukhonin, A. & Proskurin, V. (1993): New isotope geochronological data for granitoids of the Shrenk-Mamont projection of the Taimyr Peninsula.- Doklady RAN 332: 58-61 (in Russian).

Zakharov, Y., Ravich, M. & Shulyatin, O. (1977): Metamorphic facies of the Taimyr folded area.- In: Asian Metamorphic Complexes, Novosibirsk, Nauka, 164-176 (in Russian).

Zonenshain, L. & Natapov, L. (1987): Tectonic history of the Arctic Region..- In: Topical Tectonic Problems of Oceans and Continents, Moscow, Nauka, 31-57 (in Russian).

Zonenshain, L., Kuzmin, M., & Natapov, L. (1990): The Geology of the USSR: A plate tectonic synthesis.- Am. Geophys. Union Geodyn. Ser. 21, Washington DC.