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**The microcline/sanidine transformation isograd in metamorphic regions:
Western Tauern Window and Merano-Mules-Anterselva complex (Eastern Alps)**

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Abstract

Lattice parameters and optic axial angles of alkali feldspars from the Penninic augen gneisses of the western Tauern Window and from the Austroalpine Merano-Mules-Anterselva unit south of it have been determined along eight N-S profiles.

Parallel and somewhat below the 500°C isotherm of the syn- to post-kinematic metamorphism of Tertiary age the K feldspars show an abrupt change in their optic axial angle and their Al-Si order. This line separates a northern area showing exclusively low microclines ($2V_x \geq 76^\circ$ and $0.95 \leq (t_1O-t_1m) \leq 1.0$) from a southern area showing "high microclines" ($2V_x \leq 76^\circ$ and $0.0 \leq (t_1O-t_1m) \leq 0.55$). The border line represents the isotherm at which the diffusive phase transformation microcline/sanidine occurred during prograde Alpine metamorphism.

The Merano-Mules-Anterselva complex is characterized by low grade Hercynian metamorphism below 500°C. In spite of the fact that north of the Deferegggen-Anterselva-Valles line the Alpine metamorphism seems to have exceeded 500°C all investigated K feldspars of the complex are low microclines.

Introduction

The temperature of the diffusive phase transformation between microcline and sanidine (T_{diff}) has not been determined experimentally because of the very slow kinetics of Al-Si ordering. This temperature can be estimated from a careful study of the structural state of alkali feldspars and their relation to metamorphic temperatures estimated by independent methods. A discussion of the available information on the temperature of this transformation is given in a separate paper by Bambauer and Bernotat (1982).

A temperature-induced boundary between a low microcline area and an intermediate to high microcline area was found in the rocks of greenschist facies of the Central Swiss Alps (Bambauer and Bernotat, 1976; Bernotat and Bambauer, 1980). According to Frey *et al.* (1976) Alpine metamorphism reaches approximately 400°C in this area. Raith (1971) and Raase and Morteani (1976) stud-

ied the optic axial angles of the K feldspars in the Penninic rocks of the central and western Tauern Window. They found that in a zone along the border of the Tauern Window, which shows a greenschist facies metamorphism, the K feldspars are low microclines, whereas in the highest-grade metamorphic central part of the Window, the K feldspars are intermediate microclines to "orthoclases". By comparing $^{18}O/^{16}O$ data from Hoernes and Friedrichsen (1974) they deduced a temperature of 500°C for the microcline/sanidine phase transition.

The Penninic rocks of the Tauern Window belong to the deepest tectonic unit of the East Alpine tectonic pile. They consist of phyllites, schists, ortho- and paragneisses and represent the basement over which the Austroalpine nappes moved to the North. The Tauern Window is surrounded on the western, southern and eastern sides by rocks of the Austroalpine "Altkristallin". The Penninic zone comprises two main lithological and tectonic units: the "Zentralgneis" and the "Schieferhülle". The

Table 1.

SAMPLE No.	2V _x	S	SAMPLE No.	2V _x	S	SAMPLE No.	2V _x	S
311	82	1.7	71.145	63	3.0	77.110	63	4.7
48	76	1.2	71.146	61	2.4	77.111	62	3.6
43	75	1.4	71.154	70	0.8	77.112	70	3.6
47	76	2.0	71.157	71	1.2	77.113	63	5.1
528	65	0.8	75.71	62	1.7	77.114	58	7.3
581	71	1.2	75.72	56	1.6	77.115	76	2.6
367	63	0.8	AZ.21	83	0.7	77.116	85	2.0
368	71	1.2	AZ.13	57	2.2	77.117	83	0.5
583	71	0.8	AZ.14	65	2.3	77.118	84	0.7
393	68	0.8	AZ.11	69	0.7	77.119	84	0.7
381	57	2.0	77.101	78	0.7	77.120	84	1.2
371	71	0.0	77.102	75	0.7	77.121	82	0.7
544	64	2.9	77.103	73	0.7	77.122	78	2.5
553	65	1.6	77.104	70	0.8	77.123	73	3.0
422	60	2.0	77.105	62	1.8	77.124	64	3.6
420	62	2.5	77.106	66	3.0	77.125	64	3.6
551	62	2.0	77.107	62	2.6	77.126	64	5.2
440	80	1.2	77.108	57	3.1	77.127	63	7.0
835	68	1.4	77.109	59	9.0	77.128	64	5.7
						77.128	73	3.0

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Table 2

sample number	a	b	c	α	β	γ	vol.	Ab	N
Profile 1: Zemmachtal									
77-101	0.85732	1.29698	.72226	90.67	115.94	87.73	.72160	3.9	41
311	0.85748	1.29652	.72222	90.63	115.95	87.70	.72137	4.6	46
AZ-21	0.85777	1.29686	.72189	90.69	115.95	87.73	.72149	4.3	40
47(2)	0.85857	1.29765	.72087	90.06	116.03	89.74	.72166	3.8	21
77-102	0.85690	1.29765	.72086	90.28	115.98	88.98	.72048	7.1	27
77-105	0.85785	1.29779	.72078	90.02	116.00	89.92	.72126	4.9	35
77-106	0.85746	1.29801	.72075	90.22	115.99	89.28	.72098	5.7	39
Profile 2a: Stilluppatal									
77-115/2	0.85727	1.29622	.72210	90.66	115.93	87.65	.72100	5.7	53
77-115/1	0.85859	1.29895	.72068	90.00	116.00	90.00	.72239	1.6	26
77-114/3	0.85770	1.29802	.72055	90.13	116.01	89.60	.72093	5.9	36
528(1)	0.85739	1.29849	.72054	90.18	115.97	89.37	.72116	5.2	23
528(2)	0.85922	1.29850	.72057	90.13	116.04	89.79	.72229	1.9	25
581	0.85781	1.29785	.72092	90.21	116.01	89.36	.72128	4.9	36
367	0.85840	1.29796	.72067	90.04	115.99	89.75	.72172	3.6	25
368	0.85787	1.29789	.72053	90.01	115.96	89.90	.72128	4.9	25
583	0.85893	1.29796	.72055	90.08	116.05	89.74	.72171	3.6	28
393	0.85882	1.29766	.72059	90.10	116.02	89.75	.72164	3.6	18
381	0.85675	1.29750	.72061	90.03	115.99	89.90	.72004	8.4	26
371/1	0.85713	1.29698	.72070	90.02	116.02	89.84	.71995	8.6	26
371/2	0.85770	1.29707	.72066	90.04	116.04	89.84	.72032	7.6	21
371/3	0.85703	1.29670	.72139	90.40	115.93	88.73	.72078	6.3	28
371/6	0.85657	1.29820	.72046	90.01	116.01	89.90	.72001	8.4	39
553	0.85693	1.29741	.72076	90.02	116.03	89.87	.72002	8.4	35
551/2	0.85711	1.29747	.72056	90.00	116.03	89.99	.72001	8.4	35
420	0.85739	1.29776	.72082	90.09	116.01	89.68	.72081	6.2	26
835	0.85690	1.29787	.72061	90.00	116.01	89.98	.72023	7.8	44
Profile 2b: Ahrntal									
71-146	0.85663	1.29789	.72102	90.28	115.98	89.00	.72054	7.0	32
71-151	0.85781	1.29796	.72044	90.01	115.95	89.87	.72128	4.9	33
71-154	0.85764	1.29767	.72067	90.05	115.98	89.76	.72102	5.6	29
71-157	0.85803	1.29730	.72068	90.03	115.97	89.83	.72118	5.2	22

Profile 2c: Val Aurina

AA-73/14	low microcline																		
AA-73/15	low microcline																		
AA-5-C	low microcline																		
AA-5-B		0.85719	1.29677	.72204	90.63	115.93	87.72	.72121	5.1	57									
AA-73-17		0.85788	1.29666	.72229	90.66	115.94	87.64	.72190	3.1	64									
AA-6-A		0.85785	1.29664	.72220	90.67	115.92	87.65	.72189	3.1	29									
AA-6		0.85787	1.29602	.72211	90.63	115.94	87.77	.72143	4.4	40									
AA-06-A/1		0.85784	1.29637	.72224	90.64	115.95	87.67	.72159	3.9	60									
AA-06-A/2	low microcline																		
AA-06-B/1		0.85817	1.29670	.72223	90.64	115.97	87.71	.72196	2.9	44									
AA-06-B/2		0.85804	1.29659	.72223	90.65	115.97	87.69	.72177	3.4	55									

Profile 3: Zillertal

77-117		0.85727	1.29673	.72219	90.68	115.95	87.70	.72127	4.9	41
77-120		0.85732	1.29724	.72208	90.63	115.94	87.79	.72160	3.9	29
77-129		0.85726	1.29700	.72188	90.63	115.93	87.79	.72125	4.9	40
77-123		0.85739	1.29671	.72218	90.62	115.93	87.73	.72148	4.3	39
77-128(1)	low microcline									
77-128(2)		0.85734	1.29838	.72035	90.01	116.02	89.95	.72058	6.9	57

Profile 4: Wilde Gerlos Tal

77-170/2		0.85763	1.29659	.72236	90.66	115.93	87.63	.72177	3.4	41
77-165		0.85765	1.29666	.72226	90.66	115.94	87.63	.72165	3.8	53
77-163(1)	low microcline									
77-163(2)		0.85821	1.29766	.72104	90.04	116.06	89.73	.72137	4.6	20

Profile 5: Krimmler Achantal

77-183/2		0.85767	1.29660	.72215	90.63	115.88	87.64	.72190	3.0	18
77-178(1)		0.85779	1.29650	.72232	90.64	115.97	87.69	.72161	3.9	22
77-178(2)	high microcline									
77-176		0.85817	1.29749	.72081	90.03	116.00	89.70	.72135	4.7	22

Profile 6: Obersulzbachtal

77-139	0.85812	1.29646	.72234	90.65	115.94	87.64	.72200	2.7	37
77-138(1)	0.85811	1.29676	.72221	90.71	115.96	87.61	.72189	3.1	22
77-138(2)	0.85828	1.29750	.72121	90.03	115.95	89.78	.72216	2.3	21
77-134(1)	low microcline								
77-134(2)	high microcline								
77-133	0.85920	1.29774	.72061	90.13	115.99	89.52	.72221	2.1	23
77-132	0.85801	1.29782	.72059	90.07	116.00	89.80	.72117	5.2	30

Profile 7: Untersulzbachtal

77-153/2	0.85814	1.29676	.72245	90.66	115.95	87.64	.72227	1.9	36
77-146(1)	low microcline								
77-146(2)	0.85833	1.29770	.72063	90.22	115.96	89.28	.72163	3.8	18
77-145	0.85697	1.29777	.72057	90.07	116.01	89.88	.72019	8.0	36

Profile 8: Graratspitz

77-2061A(1)	0.85768	1.29671	.72135	90.46	115.93	88.47	.72126	4.9	22
77-2061A(2)	0.85710	1.29715	.72114	90.07	116.01	89.37	.72050	7.1	24
77-2031(1)	low microcline								
77-2031(2)	high microcline								
77-2001	0.85791	1.29709	.72096	90.15	115.99	89.33	.72109	5.4	32