Fig.V-9 Geological map and localities of samples of the Katsuma quartzdiorite.

1: Quarternary system, 2: Katsuma quartzdiorite, 3: Ochiai granite, 4: Hetrogeneous granite, 5: Takato granite, 6: Minakata granodiorite, 7: Hiji quartzdiorite, 8: Amphibolite, 9: pelitic-psammitic metamorphic rocks, 10: Sambagawa metamorphic rocks, 11: fault, 12: foliation.

mi: Mibu River, sn: Shinzan River, on: Onnasawa River, os: Osokura River, si: Shingu River, do: Dodomeki River.

GA: Gatsuzo-yama mountain, MI: Mitsukai-yama mauntain, TO: Tokura-yama mauntain.

MTL: Median Tectonic Line, ISTL: Itoigawa-Shizuoka Tectonic Line.

Whole rock chemical compositions of these samples are given in TableV-3. The Rb-Sr and Sm-Nd data are given in TableV-4.

In the whole-rock samples, FUJ-05 is substantially altered, and most of biotites were changed to chlorite by chloritization. MU-05 includes block of pelitic metamorphic rock. These samples are off the differentiation trend in SiO_2-oxides and SiO_2-minor element diagrams, and do not plotted on the isochron. ON-28 and ON-32 are leucocratic rock, which is included in this body, is mainly composed of plagioclase and a small amount of quartz, hornblende and biotite. ON-28 is substantially altered, and most of biotites were changed to chlorite. The chemical compositions of ON-28 and ON-32 are highly rich in Al_2O_3, CaO and Na_2O, and are similar to that of andesine. These four samples are excluded from the regression. The eight samples define an isochron age of 121±26Ma(MSWD(mean square of weighted deviates)=0.52) with a SrI of 0.70754±0.00011(2σ)(Fig.V-10). The same examination as the Otagiri granites suggests that this isochron is not pseudo-isochron. The leucocratic inclusion(ON-32) does not plotted on this isochron. This suggests that these leucocratic inclusions are not early stage cumulate of this body. In the Sm-Nd system, an isochron age of 172±44Ma was calculated(Fig.V-11), but the difference between this age and Rb-Sr whole rock isochron age is not clear thinking the range of error. $^{143}Nd/^{144}Nd$ ratios of samples were within 0.000035 (from 0.512271 to 0.512306). Therefore importance of 172Ma is not emphasized, because each ratio has an average error of 0.000011 in measurement.

Ichida granite

The whole-rock samples were collected from the Ichida granite(Fig.V-12).

Table V-3 Whole-rock chemical compositions of the Katsuma quartzdiorite.

Sample No.	FUJ-05	RY-01	MU-05	ON-27	ON-28	ON-29	ON-30	ON-31	ON-32	OS-06	OS-11	NA-03
SiO_2	59.09	60.65	62.83	57.13	58.68	56.52	52.40	54.86	57.15	58.67	58.06	54.73
TiO_2	0.90	0.80	0.86	0.97	0.22	0.84	1.07	1.05	0.14	0.80	0.90	1.06
Al_2O_3	16.87	16.79	16.22	18.03	23.42	19.51	18.24	18.37	25.67	17.21	17.32	18.42
Fe_2O_3	0.82	1.41	1.17	0.67	0.26	0.99	0.63	2.75	0.26	0.67	0.33	0.03
FeO	5.66	4.30	4.86	6.21	0.58	4.85	7.73	4.88	0.28	5.14	5.75	6.87
MnO	0.12	0.09	0.11	0.12	0.02	0.10	0.16	0.13	0.01	0.11	0.11	0.11
MgO	3.69	2.81	2.82	4.04	0.40	3.56	5.20	4.32	0.34	3.30	3.62	4.27
CaO	3.76	6.02	5.83	7.48	7.48	7.90	8.67	7.67	9.39	6.46	6.93	7.69
Na_2O	2.72	2.92	3.22	2.70	6.09	3.35	2.71	2.83	5.98	2.86	2.77	2.89
K_2O	2.32	1.23	0.79	1.12	0.54	1.01	0.92	0.95	0.27	1.70	1.56	1.27
P_2O_5	0.15	0.14	0.15	0.17	0.04	0.15	0.17	0.19	0.04	0.14	0.17	0.20
L.O.I.	3.83	2.01	1.60	2.31	2.07	1.88	2.77	1.78	0.47	1.81	1.88	2.17
Total	99.94	99.17	100.47	100.97	99.80	100.67	100.66	99.78	100.01	98.86	99.40	99.71
Ba	583	510	287	306	122	241	266	246	119	411	335	284
Cr	62	32	27	47	n.d.	33	52	42	n.d.	47	50	48
Cu	17		4	17	5	12	33	17	n.d.			16
Nb	9	5	8	6	n.d.	6	7	7	n.d.	8	8	7
Ni	19	13	13	19	3	13	24	19	7	17	16	19
Rb	84	37.5*	23	34.0*	16	29.6*	23.3*	26.4*	8	55.8*	52.7*	39.8*
Sr	346	401*	421	411*	626	452*	401*	418*	693	369*	365*	424*
V	172	133	137	172	18	137	175	190	15	154	159	181
Y	29	14	27	20	4	25	19	25	4	22	22	21
Zn	78		82	86	13	71	109	91	11			90
Zr	148	131	194	65	62	101	38	153	41	119	88	114

*determined by isotope dilution method
L.O.I.:Loss on ignition, n.d.:not detected.

Table V-4 Trace element concentrations and isotopic data of the Katsuma quartzdiorite.

Sample No.	Rb(ppm)	Sr(ppm)	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr(2\sigma)$	Sm(ppm)	Nd(ppm)	$^{147}Sm/^{144}Nd$	$^{143}Nd/^{144}Nd(2\sigma)$	NdI*
FUJ-05	84**	346**	0.7058	0.70828(1)	5.05	20.7	0.1477	0.512265(11)	
RY-01	37.5	401	0.2706	0.70806(1)	2.45	12.4	0.1195	0.512281(10)	0.512187
MU-05	23**	421**	0.1595	0.70848(1)					
ON-27	34.0	411	0.2394	0.70798(1)	3.71	16.7	0.1342	0.512291(10)	0.512185
Biotite	543	13.4	118.9	0.81386(3)	0.0641	0.367	0.1056	0.512284(36)	
Hornblende	4.05	70.4	0.1663	0.70786(1)	9.54	37.1	0.1555	0.512262(12)	
Felsic f.	11.9	745	0.04625	0.70783(1)	0.161	1.42	0.06872	0.512219(14)	
ON-28	16**	626**	0.07580	0.70794(1)	0.489	3.13	0.09445	0.512291(11)	0.512216
ON-29	29.6	452	0.1893	0.70793(1)	4.42	19.1	0.1399	0.512303(12)	0.512193
Biotite	470	21.8	62.60	0.76260(3)	0.163	0.780	0.1268	0.512228(30)	
Hornblende	4.93	74.4	0.1919	0.70786(1)	12.8	46.5	0.1663	0.512282(12)	
Felsic f.	16.5	709	0.06742	0.70784(1)	0.268	2.16	0.07524	0.512301(14)	
ON-30	23.3	401	0.1678	0.70779(1)	3.55	19.7	0.1091	0.512274(10)	0.512188
ON-31	26.4	418	0.1826	0.70780(1)	4.65	19.9	0.1410	0.512306(10)	0.512195
ON-32	8**	693**	0.03423	0.70774(1)	0.551	3.83	0.08714	0.512247(17)	0.512178
OS-06	55.8	369	0.4378	0.70831(1)	4.13	21.7	0.1153	0.512271(10)	0.512180
OS-11	52.7	365	0.4182	0.70822(1)	3.62	16.2	0.1351	0.512303(11)	0.512196
Biotite	705	5.87	357.8	1.01763(6)					
Hornblende	3.66	68.3	0.1551	0.70801(1)	8.08	32.0	0.1525	0.512308(11)	
Felsic f.	11.4	559	0.05915	0.70792(1)					
NA-03	39.8	424	0.2721	0.70797(1)	3.83	17.0	0.1358	0.512304(10)	0.512197
Biotite	687	13.4	149.9	0.83090(4)					
Hornblende	4.15	93.3	0.1286	0.70784(1)	8.88	33.0	0.1629	0.512295(11)	
Felsic f.	5.53	685	0.02335	0.70773(1)	0.261	2.27	0.07043	0.512272(14)	

Felsic f.: Felsic fractions
*corrected by Rb-Sr whole rock isochron age:121 Ma, **analyzed by XRF

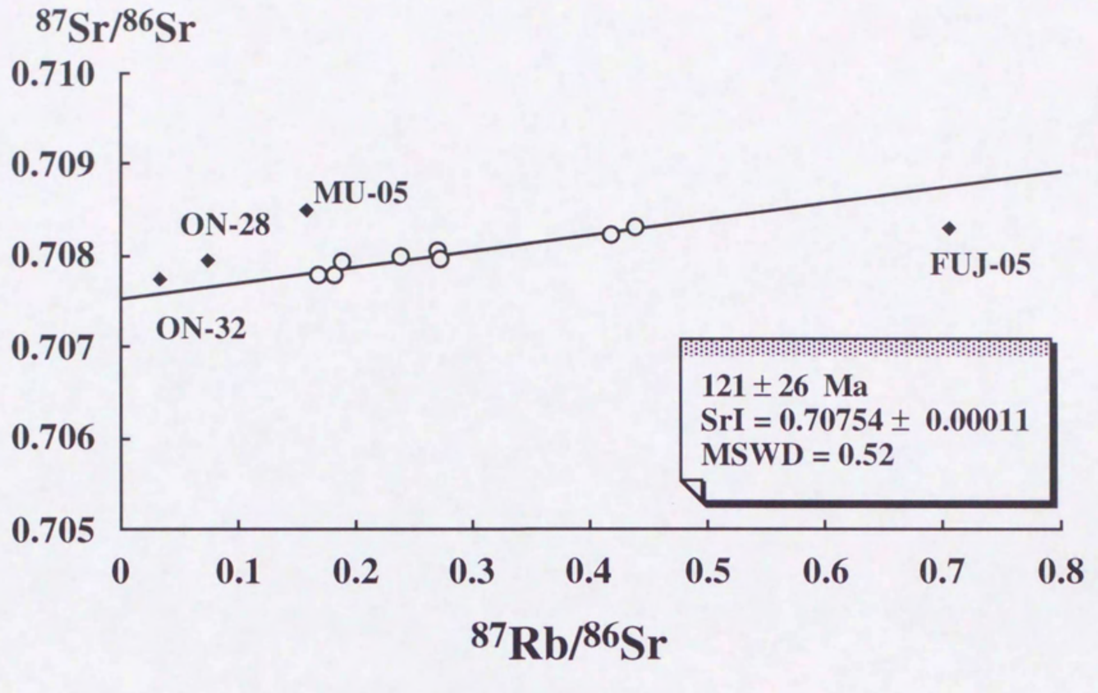


Fig.V-10 Rb-Sr whole-rock isochron for the Katsuma quartzdiorite.

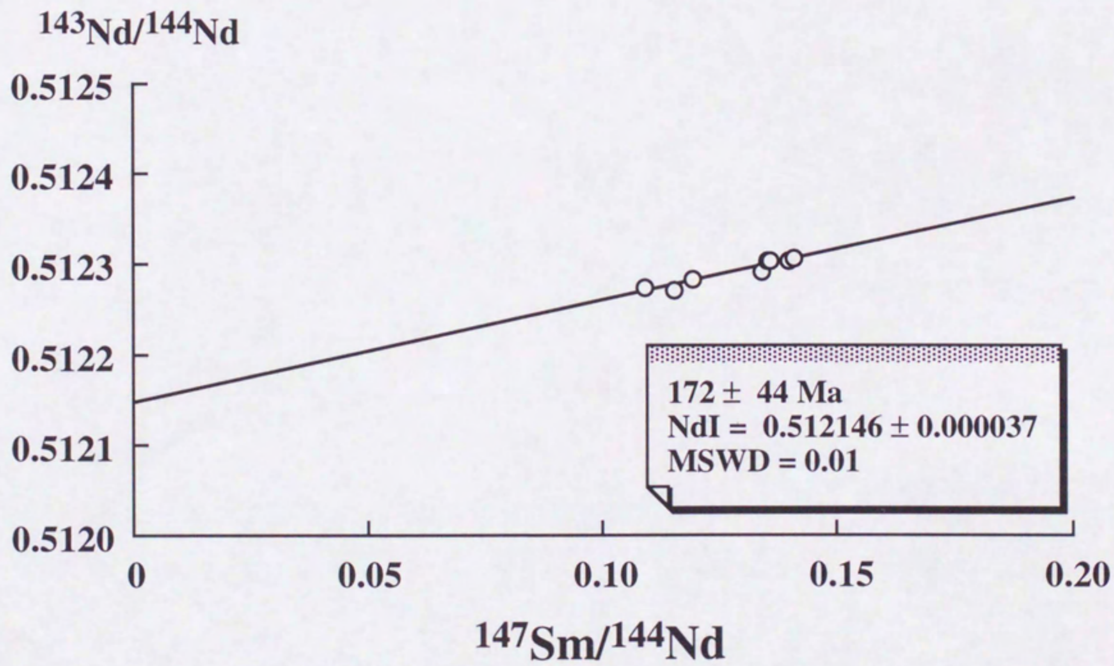


Fig.V-11 Sm-Nd whole-rock isochron for the Katsuma quartzdiorite.

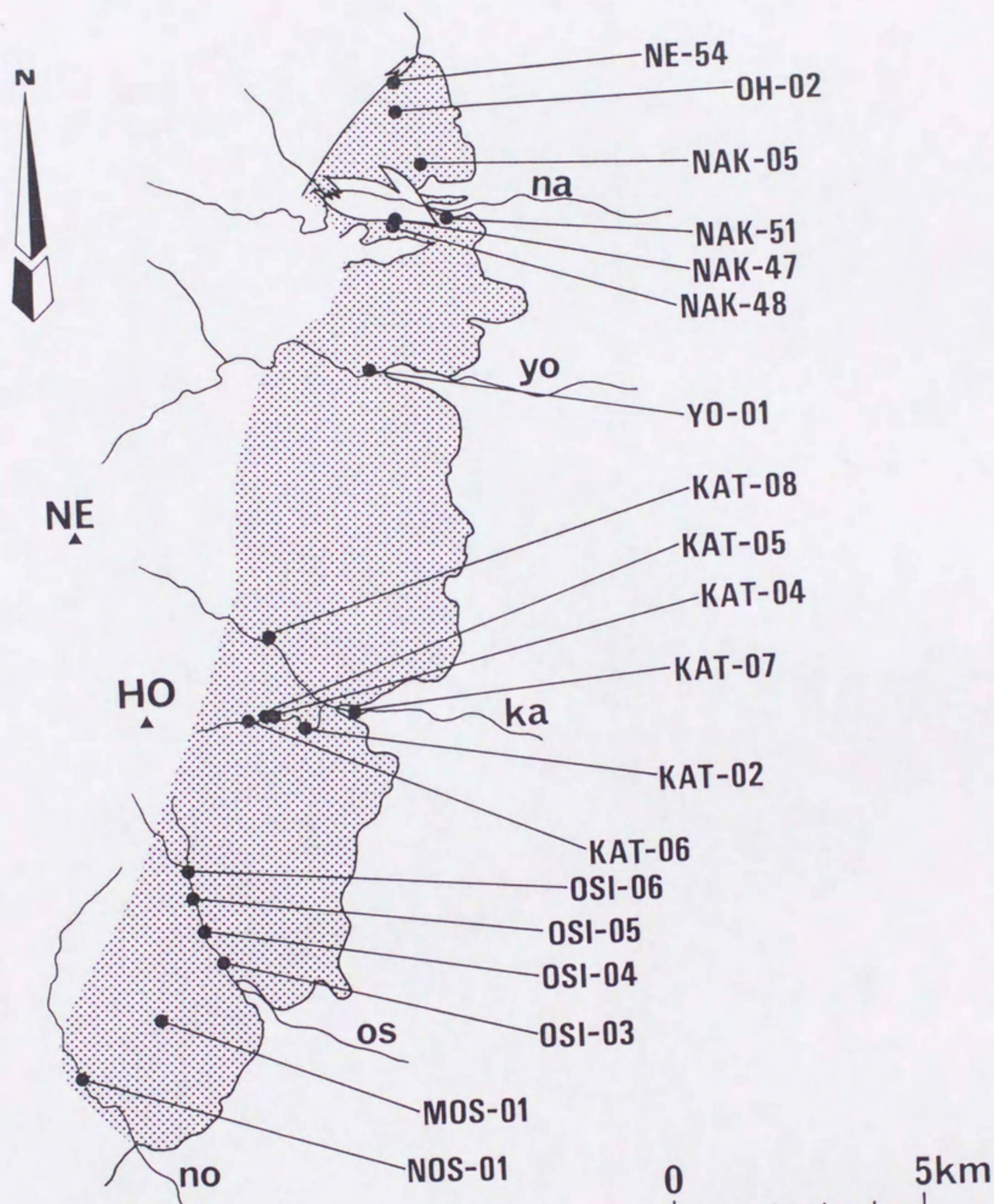


Fig.V-12 Sample localities of the Ichida granite.
na:Nakatagiri River, yo:Yotagiri River, ka:Katagirimatsu River, os: Osawa River, no:Nosoko River.
Ne:Nenjyo-dake mountain, Ho:Hontakamori-yama mountain.

Chemical compositions of these whole rock samples are given in TableV-5. The Rb-Sr and Sm-Nd data of these samples are given in TableV-6.

SiO_2-oxides diagrams and SiO_2-minor element diagrams are given in FiguresV-13 and 14.

The sample selection is carried out in the way shown in Figure V-1. The six samples selected from the northern body form an isochron indicating an age of 100±24Ma with a SrI of 0.70818±0.00022(2σ)(Fig.V-15).

Takato granite

The Takato granite is divided into two bodies, northern and southern bodies, based on their distribution in the field(Fig.V-16). The southern body is composed of biotite hornblende tonalite and granodiorite. The northern body is composed mainly of biotite granite, but partly includes hornblende.

The whole-rock samples were collected from the Takato granite(Fig.V-17). Two samples were collected from the two-mica granite that is exposed as small body in the Sawa River. A sample is collected from the Tomigata granite(Kawachi et al., 1983) too.

Whole rock chemical compositions of these samples are given in Table V-7. The Rb-Sr and Sm-Nd data are given in TableV-8.

SiO_2-oxides diagrams and SiO_2-minor element diagrams are given in FiguresV-18 and 19. Rb and Sr contents of northern body are obviously different from those of southern one. The northern body is characterized by high Rb and Sr, and the southern body is characterized by low Rb and Sr. In southern part of the northern body, there are rocks that are poor in Rb. These samples include hornblende. It is thought that these rocks derive from the southern body. In this area, both facies exist. Thus, there is a possibility that these rocks mixed. This is supported by that these

Table V-5 Whole-rock chemical compositions of the Ichida granite.

Sample No.	YO-01	NAK-48	NE-54	OH-02	NAK-51	KAT-07	NAK-05	OSI-04	MOS-01	OSI-03	NAK-47	KAT-06
SiO_2	65.65	67.12	67.21	67.27	67.38	67.76	68.00	68.21	68.31	69.13	69.75	69.93
TiO_2	0.55	0.62	0.62	0.58	0.64	0.36	0.46	0.38	0.45	0.38	0.53	0.31
Al_2O_3	16.45	16.92	15.90	16.67	16.66	16.10	16.12	15.49	15.07	15.21	16.12	15.08
FeO*	4.02	3.87	3.75	3.92	4.10	3.03	3.26	3.02	3.86	2.98	3.28	2.61
MnO	0.08	0.08	0.07	0.06	0.06	0.07	0.08	0.07	0.07	0.07	0.08	0.07
MgO	1.25	1.49	1.30	1.45	1.52	0.89	1.12	0.87	0.90	0.79	1.40	0.70
CaO	3.96	3.67	3.80	3.95	4.21	3.40	3.25	3.32	3.69	3.01	3.39	2.70
Na_2O	3.36	3.48	3.41	3.24	3.17	3.50	3.64	3.49	3.58	3.40	3.56	3.41
K_2O	2.34	2.27	2.03	2.41	2.28	2.54	2.24	2.41	1.78	3.03	2.40	3.05
P_2O_5	0.19	0.25	0.15	0.21	0.21	0.12	0.16	0.12	0.13	0.13	0.17	0.10
LOI		1.11	1.10	0.98	0.97		1.17				0.86	
Total	98.27	100.90	99.44	100.84	101.27	98.10	99.60	97.72	98.28	98.44	101.62	98.25
Ba	702	416	623	652	654	757	406	613	498	939	345	518
Cu	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cr	6											
Nb	11	12	9	11	10	10	10	9	11	10	13	11
Ni	3	10	5	6	4	3	5	6	7	5	7	7
Rb	65.7	104	66.7	72.8	67.1	67.1	91	62.1	77	71.4	78	77.6
Sr	487	427	425	507	496	425	402	429	318	404	385	353
V								19	26	22		17
Y	13	18	9	17	14	16	17	17	28	15	18	17
Zn	69	76	83	72	75	58	66	58	77	63	68	55
Zr	232	216	193	220	240	170	189	161	263	154	188	142

LOI: Loss on ignition, n.d.: not detected.

Table V-5 (conitued).

Sample No.	KAT-04	KAT-02	OSI-05	OSI-06	NOS-01	KAT-08	KAT-05
SiO_2	70.29	70.30	70.38	70.88	71.30	71.88	73.05
TiO_2	0.33	0.30	0.34	0.28	0.30	0.25	0.21
Al_2O_3	14.92	15.06	14.66	14.88	14.49	14.25	14.28
FeO*	2.77	2.54	2.78	2.46	2.31	2.09	1.94
MnO	0.07	0.06	0.06	0.06	0.06	0.05	0.05
MgO	0.73	0.65	0.70	0.55	0.63	0.50	0.38
CaO	2.89	2.45	2.67	2.46	2.74	1.61	1.89
Na_2O	3.49	3.17	3.16	3.38	3.54	3.23	3.24
K_2O	2.42	3.58	3.24	3.27	2.54	3.87	3.57
P_2O_5	0.11	0.10	0.11	0.08	0.07	0.08	0.06
LOI							
Total	98.31	98.50	98.42	98.57	98.25	98.04	98.90
Ba	393	985	995	866	488	701	726
Cu	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cr							
Nb	11	10	9	10	13	15	11
Ni	4	5	6	8	5	9	6
Rb	72.2	81.5	71.6	82.4	50	118	85.7
Sr	354	375	375	342	424	232	287
V	17	16		17	20	16	12
Y	19	12	13	16	18	19	20
Zn	59	52	56	49	54	52	42
Zr	149	140	153	145	152	152	145

Table V-6 Trace element concentrations and isotopic data of the Ichida granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)	NdI*
YO-01	65.7	487	0.3907	0.70901(1)	5.77	34.3	0.1016	0.512316(10)	
NAK-48	104*	427*	0.7068	0.70952(1)					
NE-54	66.7	425	0.4539	0.70903(1)	3.79	21.8	0.1052	0.512314(9)	
OH-02	72.8	507	0.4161	0.70895(1)	5.83	36.2	0.09750	0.512291(11)	
NAK-51	67.1	496	0.3917	0.70892(1)	5.89	36.6	0.09724	0.512232(11)	
KAT-07	67.1	425	0.4572	0.70887(1)	4.44	24.0	0.1120	0.512286(11)	0.512213
NAK-05	91*	402*	0.6548	0.70917(1)					
OSI-04	62.1	429	0.4192	0.70889(1)					
MOS-01	78*	385*	0.5859	0.70958(1)					
OSI-03	71.4	404	0.5108	0.70897(1)	4.01	22.3	0.1088	0.512272(11)	0.512201
NAK-47	78*	385*	0.5859	0.70958(1)					
KAT-06	77.6	353	0.6362	0.70906(1)	3.59	18.0	0.1203	0.512311(11)	0.512232
KAT-04	72.2	354	0.5906	0.70902(1)	3.77	18.2	0.1251	0.512245(10)	
KAT-02	81.5	375	0.6293	0.70902(1)	3.45	18.6	0.1118	0.512262(11)	
NOS-01	50*	424*	0.3412	0.70911(1)					
OSI-05	71.6	375	0.5523	0.70894(1)	3.73	19.9	0.1130	0.512334(11)	0.512260
OSI-06	82.4	342	0.6973	0.70893(1)	4.40	23.8	0.1120	0.512282(10)	0.512209
KAT-08	118	232	1.472	0.71010(1)	5.88	31.2	0.1140	0.512268(11)	
KAT-05	85.7	287	0.8639	0.70946(1)	4.57	23.8	0.1162	0.512270(9)	0.512194

*corrected by Rb-Sr whole-rock isochron age:100Ma, **analyzed by XRF.

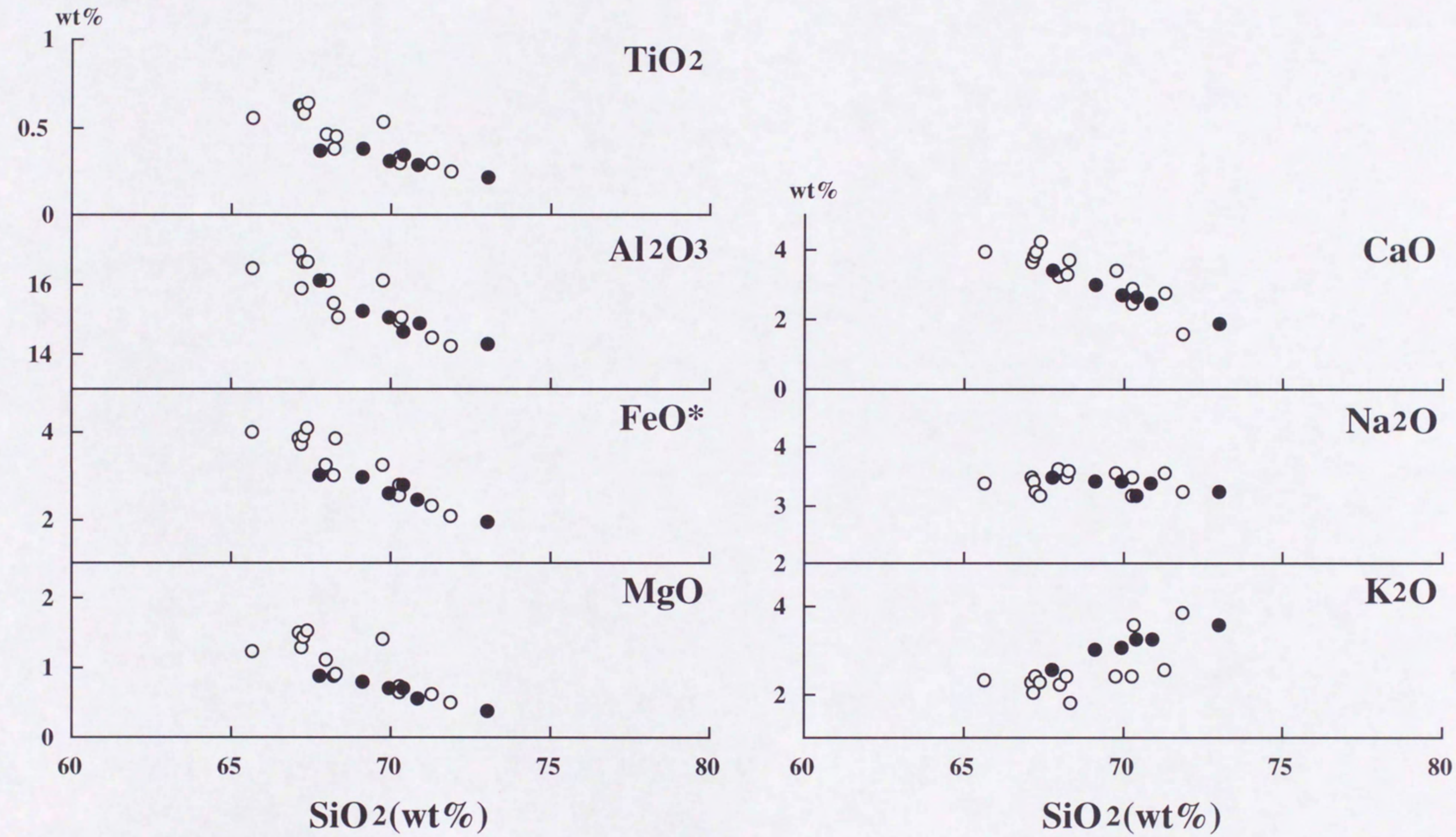


Fig.V-13 SiO_2-oxides diagrams for the Ichida granite.

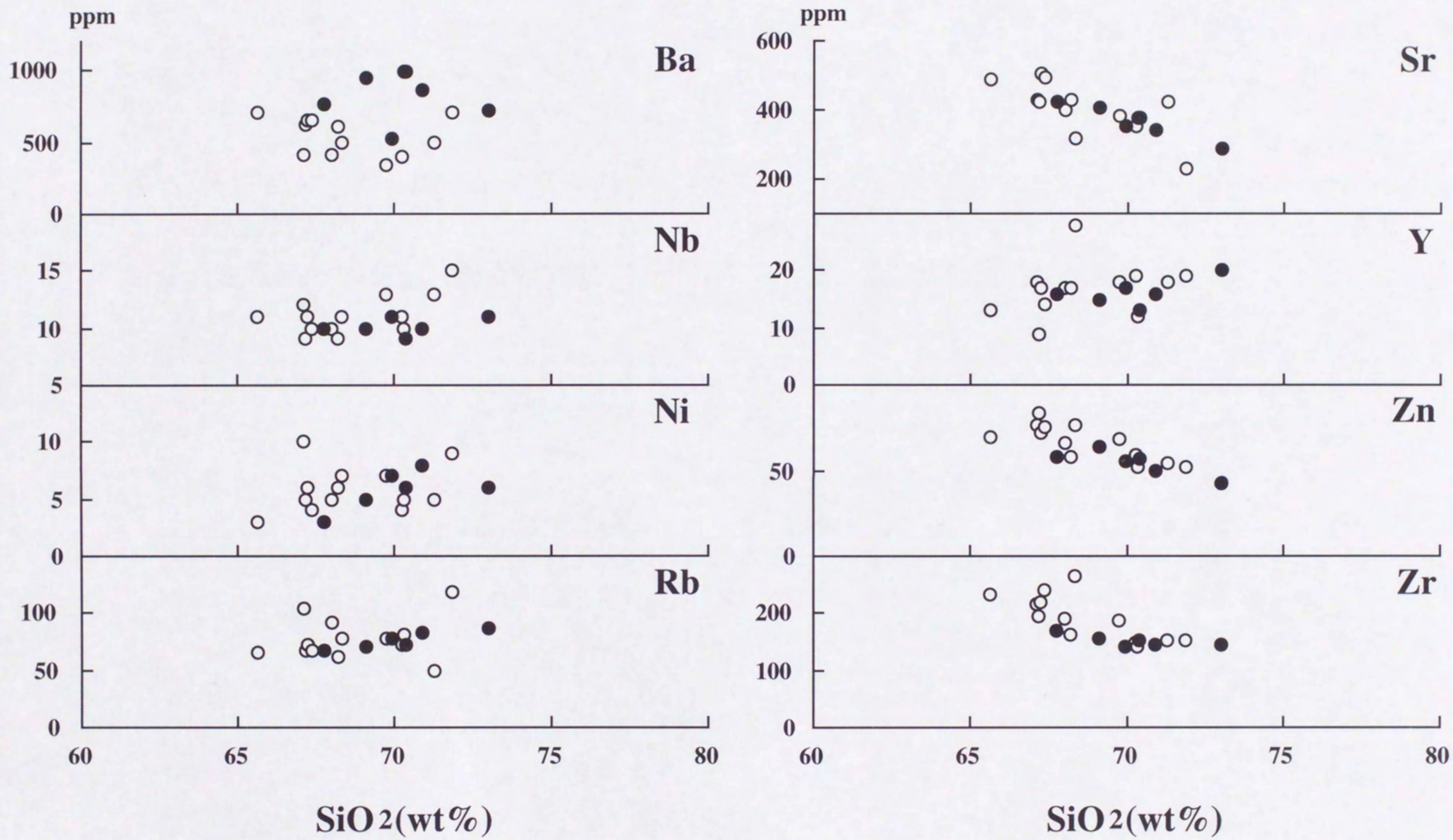


Fig.V-14 SiO_2-minor element diagrams for the Ichida granite.

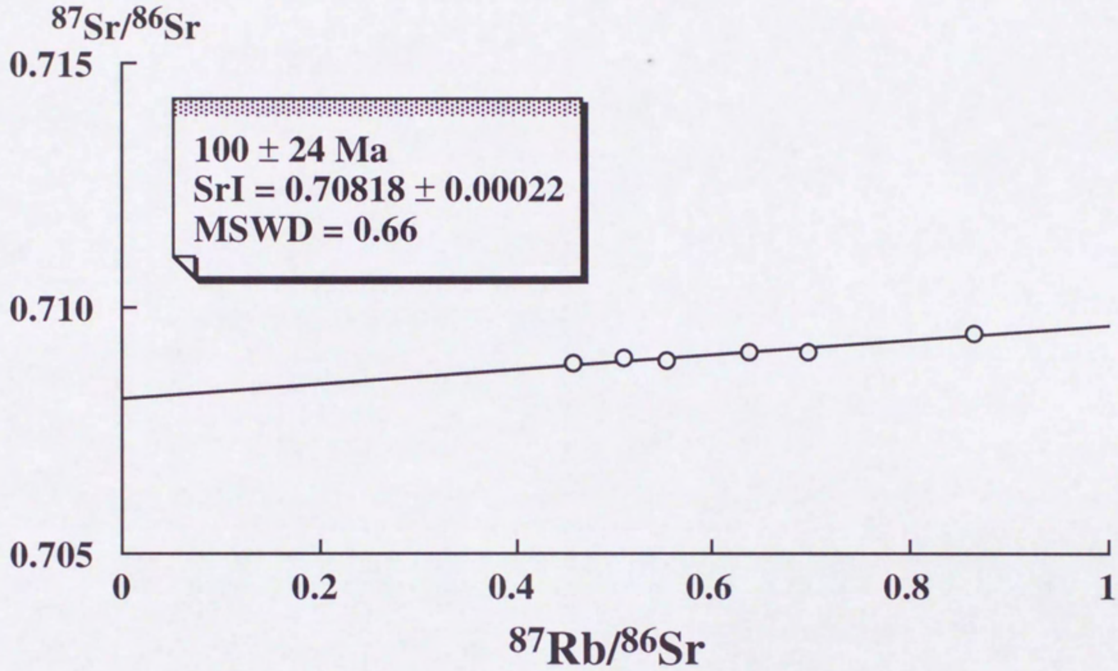


Fig.V-15 Rb-Sr whole-rock isochron for the Ichida granite.

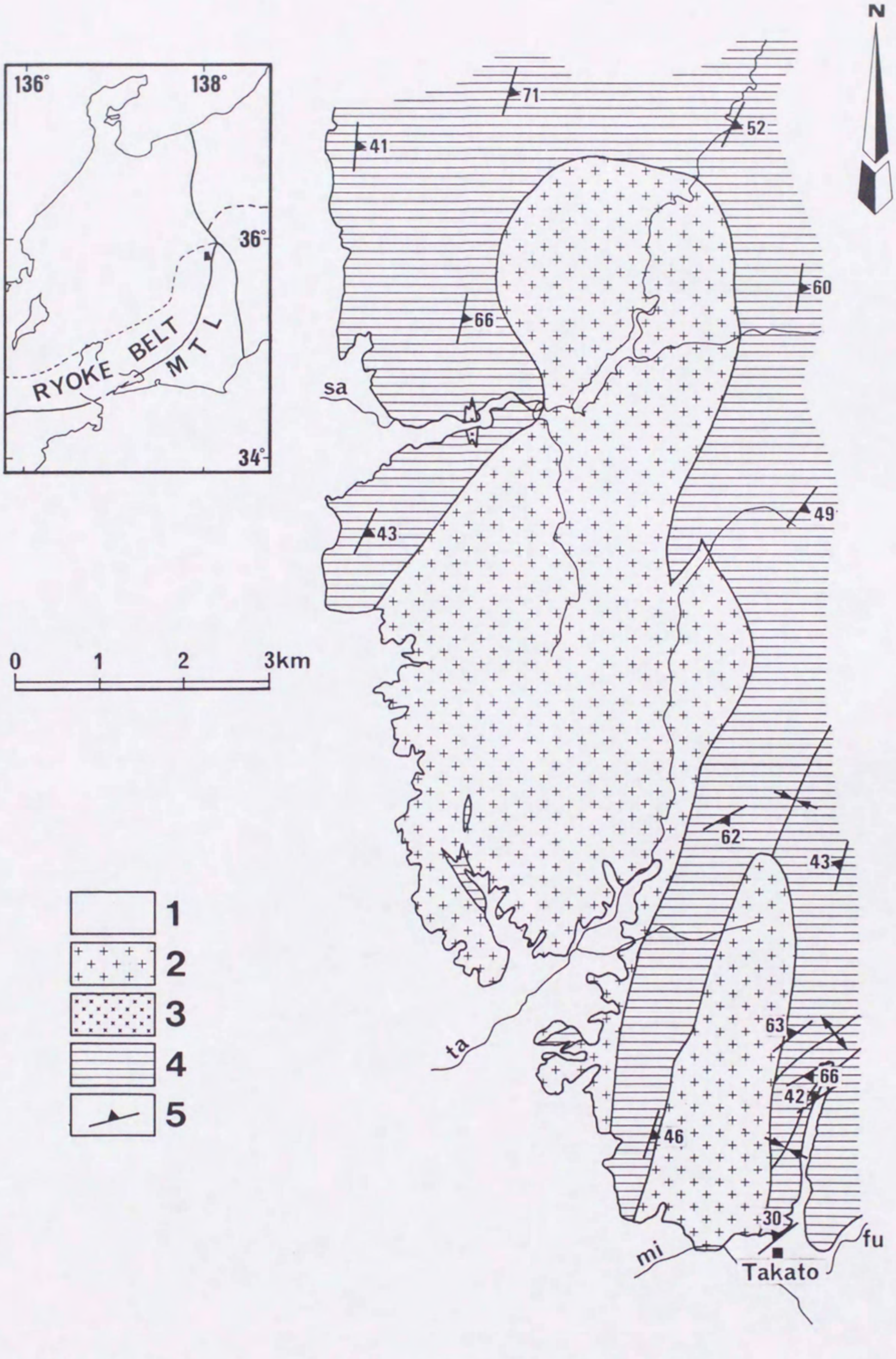


Fig.V-16 Geological map of the area north of the Takato Town.
1:Quaternary system, 2:Takato granite, 3:Two-mica granite, 4:pelitic-psammitic metamorphic rocks, 5:foliation.
sa:Sawa River, ta:Tanasawa River, mi:Mibu River, fu:Fujisawa River.

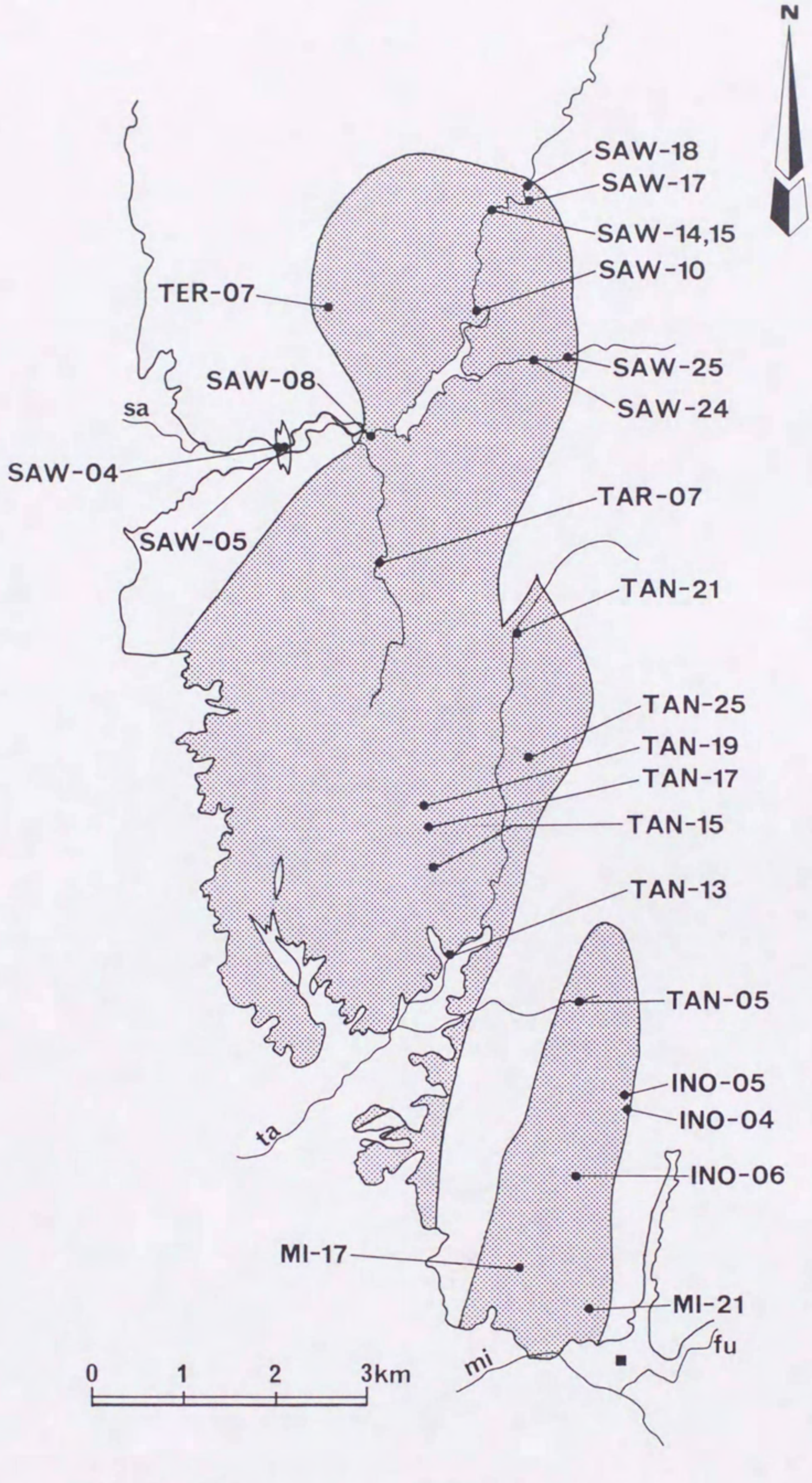


Fig.V-17 Sample localities of the Takato granite.
sa:Sawa River, ta:Tanasawa River, mi:Mibu River, fu:Fujisawa River.

Table V-7 Whole-rock chemical compositions of the Takato granite.

Sample No.	TAN-13	TAN-17	SAW-08	SAW-15	TAN-19	TAR-07	SAW-18	TAN-25	TAN-15	SAW-25	TER-07	SAW-14b
SiO_2	61.66	62.51	65.11	65.71	65.97	66.00	66.08	66.69	66.84	68.56	69.16	69.66
TiO_2	0.86	0.75	0.64	0.58	0.53	0.63	0.28	0.54	0.50	0.37	0.42	0.38
Al_2O_3	17.23	16.69	15.72	15.91	15.95	15.64	17.49	16.16	15.55	14.67	14.96	14.68
FeO*	5.22	4.76	4.95	4.90	4.59	5.04	2.45	3.50	4.21	3.23	3.61	3.25
MnO	0.09	0.09	0.09	0.11	0.08	0.09	0.06	0.07	0.08	0.08	0.08	0.07
MgO	2.43	2.14	1.35	1.29	1.07	1.34	0.71	1.43	1.02	0.77	0.93	0.79
CaO	5.77	4.91	2.82	3.20	2.67	3.11	2.59	3.75	2.49	1.73	2.19	1.82
Na_2O	3.83	3.77	3.29	4.46	3.56	3.46	4.68	3.98	3.60	3.27	3.82	3.27
K_2O	1.00	1.47	3.07	1.95	3.03	2.58	3.82	1.76	3.53	4.12	3.33	4.50
P_2O_5	0.20	0.16	0.23	0.21	0.18	0.19	0.10	0.13	0.17	0.12	0.13	0.13
Total	98.29	97.26	97.26	98.33	97.63	98.08	98.26	98.00	98.00	96.91	98.64	98.56
Ba	403	480	784	310	764	628	614	536	820	721	596	888
Cu	3		2		5	8		23	2			
Cr												
Nb	7	7	15	15	13	13	8	8	11	12	11	11
Ni	8	11	10	7	7	11	5	6	7	6	5	6
Rb	26	43	122	142	117	114	127	42	122	154	128	157
Sr	616	549	333	263	286	350	356	490	324	225	263	250
V	71	76	73	58	59	67	27	46	52	36	38	40
Y	12	14	33	31	21	15	17	15	24	25	25	24
Zn	87	85	74	73	68	68	38	60	61	50	52	50
Zr	164	153	146	241	234	264	139	130	218	171	175	175

Table V-7 (continued).

Sample No.	TAN-21	SAW-24	SAW-17	SAW-10	MI-17	MI-22	TAN-27	MI-21	INO-05	INO-06	INO-04	TAN-05
SiO_2	70.39	70.48	71.56	73.80	63.03	63.06	63.21	63.31	64.45	64.57	65.14	65.35
TiO_2	0.33	0.33	0.31	0.15	0.79	0.75	0.85	0.79	0.75	0.69	0.77	0.62
Al_2O_3	14.67	13.94	14.16	14.35	16.77	17.41	17.22	16.81	16.92	16.73	16.52	16.42
FeO*	2.97	2.93	2.72	1.29	4.64	4.06	4.58	4.56	4.37	4.17	4.42	3.76
MnO	0.08	0.07	0.06	0.04	0.08	0.08	0.08	0.07	0.08	0.07	0.08	0.07
MgO	0.68	0.74	0.75	0.33	1.90	1.95	2.11	2.09	1.88	1.78	1.86	1.59
CaO	1.65	1.74	1.63	1.72	4.83	5.05	4.72	4.75	4.67	4.26	4.24	4.47
Na_2O	3.58	2.89	3.21	3.52	3.59	4.24	3.87	3.58	3.96	4.27	4.02	3.72
K_2O	3.82	3.96	3.89	3.95	1.51	1.27	1.45	1.29	1.61	1.62	1.71	1.57
P_2O_5	0.11	0.12	0.10	0.05	0.18	0.20	0.21	0.19	0.18	0.17	0.18	0.15
Total	98.28	97.20	98.40	99.19	97.31	98.08	98.31	97.44	98.88	98.33	98.92	97.72
Ba	574	564	607	292	449			503	514	513	507	494
Cu					4				2		3	
Cr		6										
Nb	10	12	10	6	8			7	9	8	8	7
Ni	4	13	7	7	8			8	6	10	15	7
Rb	156	148	127	117	35.9	28.5	35.9	31.2	39.1	40.1	39.0	37.9
Sr	216	156	201	217	586	637	598	614	581	560	551	553
V	35	34	31	13	59			59	58	51	54	52
Y	23	25	20	12	14			10	14	13	15	14
Zn	41	44	37	19	80			81	84	77	81	72
Zr	157	134	167	86	175			162	162	168	159	140

Table V-7 (continued).

Sample No.	SAW-04	SAW-05	MI-18
SiO_2	72.06	72.69	72.89
TiO_2	0.13	0.11	0.10
Al_2O_3	14.14	14.43	13.81
FeO*	1.61	1.38	1.36
MnO	0.06	0.05	0.08
MgO	0.25	0.22	0.18
CaO	1.12	1.10	0.83
Na_2O	3.47	3.49	3.28
K_2O	3.55	3.75	4.28
P_2O_5	0.09	0.09	0.03
Total	96.47	97.32	96.83
Ba	563	491	251
Cu			
Cr			
Nb	12	12	8
Ni	12	7	5
Rb	132	141	196
Sr	225	201	85
V	7	6	10
Y	13	13	37
Zn	40	26	21
Zr	95	84	73

Table V-8 Trace element concentrations and isotopic data of the Takato granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)	NdI*
TAN-13	26**	616**	0.1203	0.70882(1)					
TAN-17	43**	549**	0.2251	0.70878(1)					
SAW-08	122**	333**	1.060	0.71022(1)					
SAW-15	142**	263**	1.562	0.70971(1)					
TAN-19	117**	286**	1.184	0.70916(1)					
TAR-07	114**	350**	0.9425	0.70952(1)					
SAW-18	127**	356*	1.032	0.70922(1)					
TAN-25	42**	490**	0.2498	0.70894(1)					
TAN-15	122**	324**	1.090	0.70940(1)					
SAW-25	154	225	1.981	0.71012(1)	3.88	18.3	0.1280	0.512335(10)	0.512262
TER-07	128	263	1.408	0.70944(1)	5.41	27.9	0.1170	0.512300(11)	0.512233
SAW-14b	157	250	1.819	0.70991(1)	5.87	30.6	0.1159	0.512302(12)	0.512236
TAN-21	156	216	2.086	0.71030(1)	6.94	35.9	0.1167	0.512302(12)	0.512235
SAW-24	148	156	2.756	0.71068(1)	4.40	20.5	0.1298	0.512296(11)	
SAW-17	127	201	1.830	0.70993(1)	5.43	28.2	0.1166	0.512339(10)	0.512272
SAW-10	117	217	1.557	0.70965(1)	3.06	14.6	0.1271	0.512299(13)	
MI-17	35.9	586	0.1775	0.70885(1)	2.82	14.4	0.1181	0.512262(10)	0.512195
MI-21	31.2	614	0.1472	0.70889(1)	2.82	15.4	0.1105	0.512253(12)	0.512190
MI-22	28.5	637	0.1295	0.70895(1)	3.01	15.2	0.1197	0.512268(11)	0.512200
TAN-05	37.9	553	0.1983	0.70891(1)	3.05	14.5	0.1277	0.512239(10)	0.512166
TAN-27	35.9	598	0.1736	0.70882(1)	3.03	16.4	0.1120	0.512281(11)	0.512217
INO-05	39.1	581	0.1949	0.70895(1)	2.82	12.7	0.1339	0.512291(12)	0.512215
INO-06	40.1	560	0.2070	0.70887(1)	3.48	19.6	0.1076	0.512252(10)	0.512191
INO-04	39.0	551	0.2046	0.70897(1)	2.71	11.9	0.1383	0.512288(11)	0.512209
SAW-04	132**	225**	1.698	0.71035(1)					
SAW-05	141**	201**	2.030	0.71084(1)					
MI-18	196**	85**	6.677	0.71561(1)					

*corrected by Rb-Sr whole-rock isochron age:87.3Ma, **analyzed by XRF.

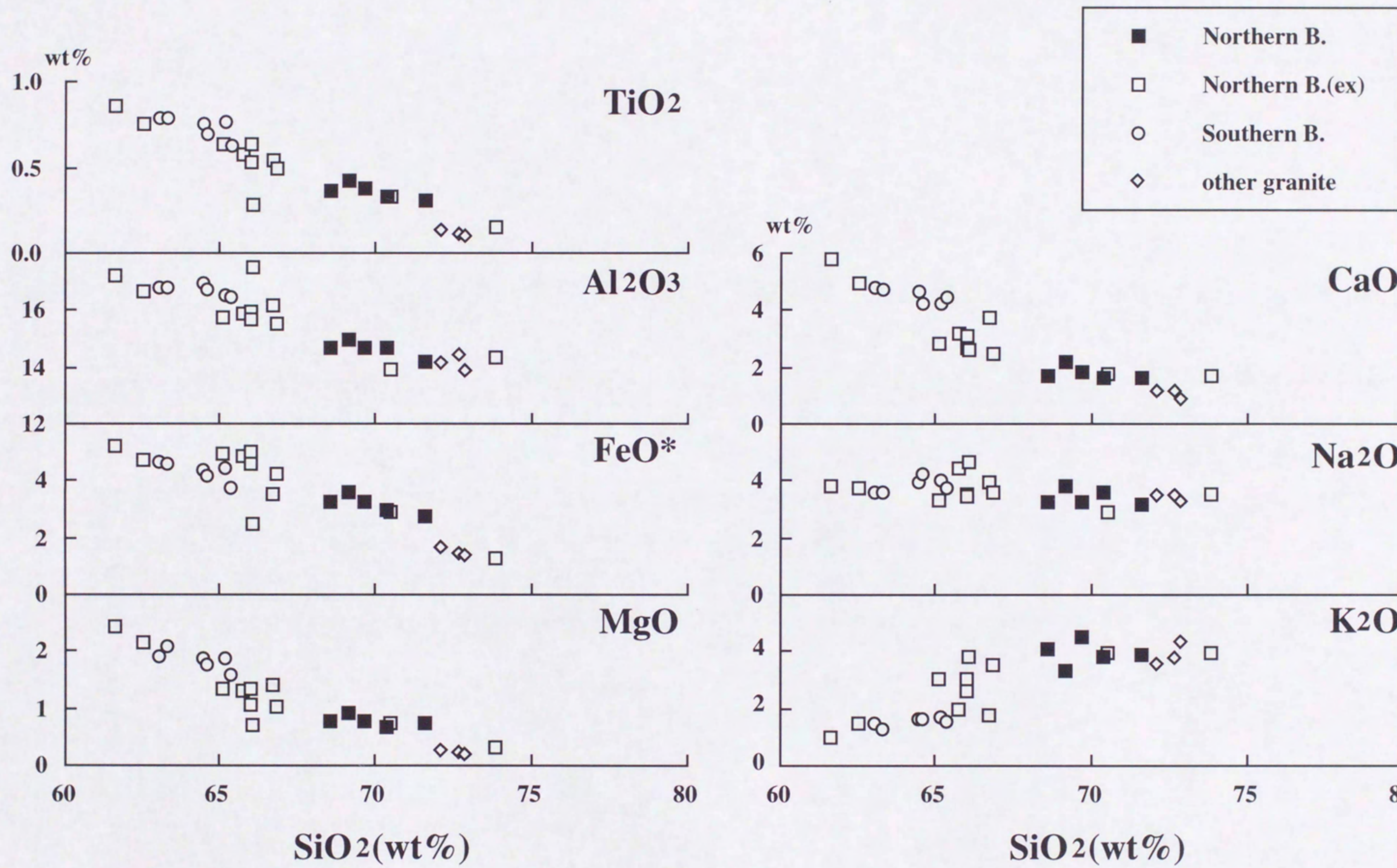


Fig.V-18 SiO2-oxides diagrams for the Takato granite.

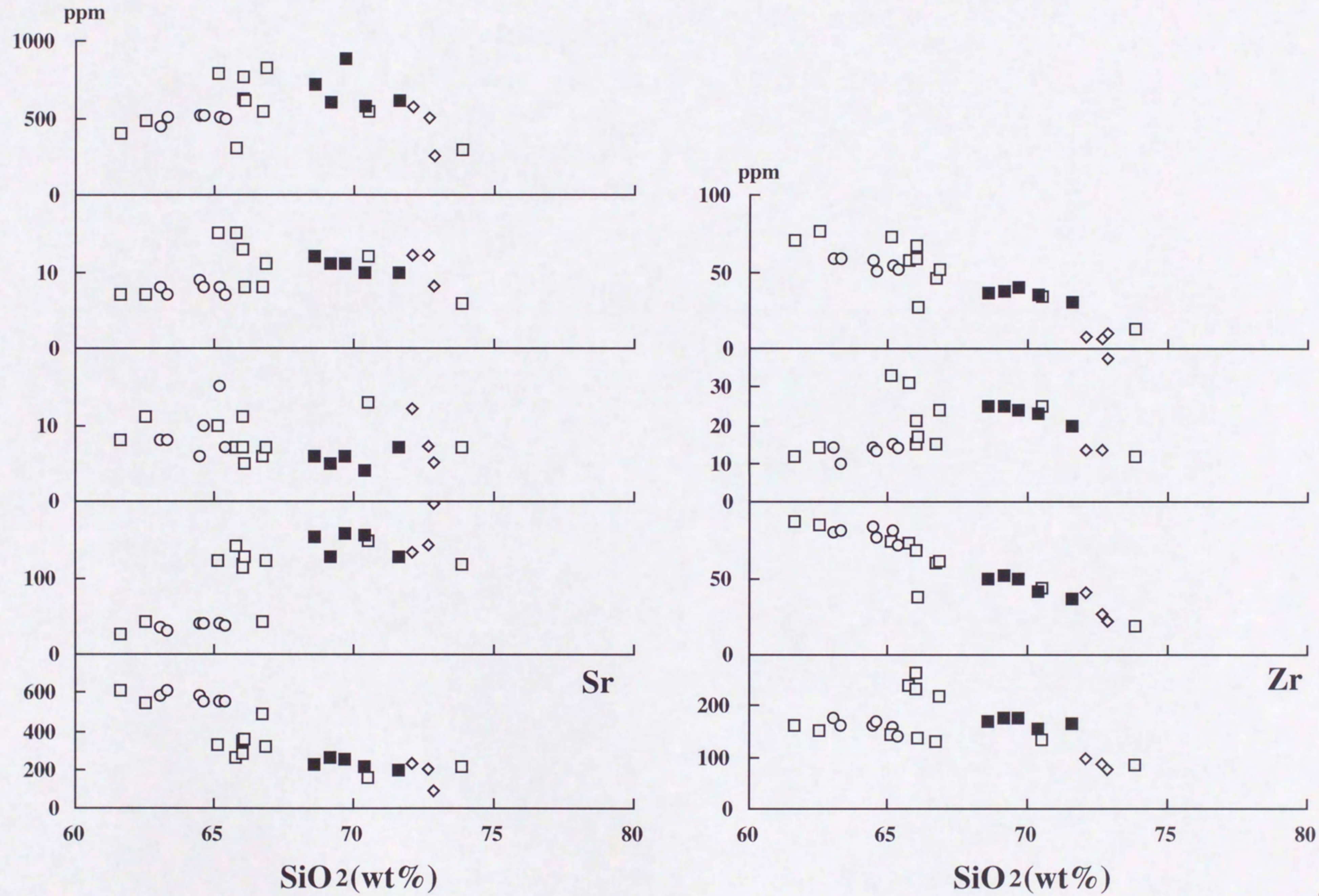


Fig.V-19 SiO2-minor element diagrams for the Takato granite.

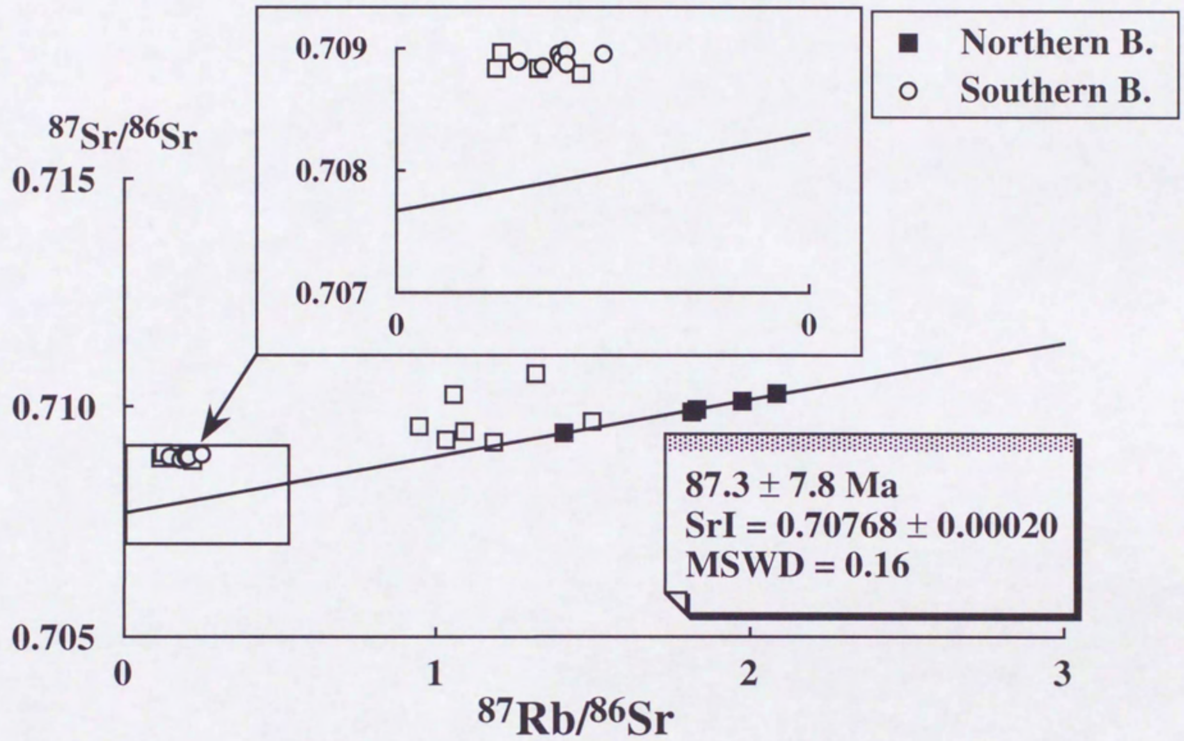


Fig.V-20 Rb-Sr whole-rock isochron for the Takato granite.

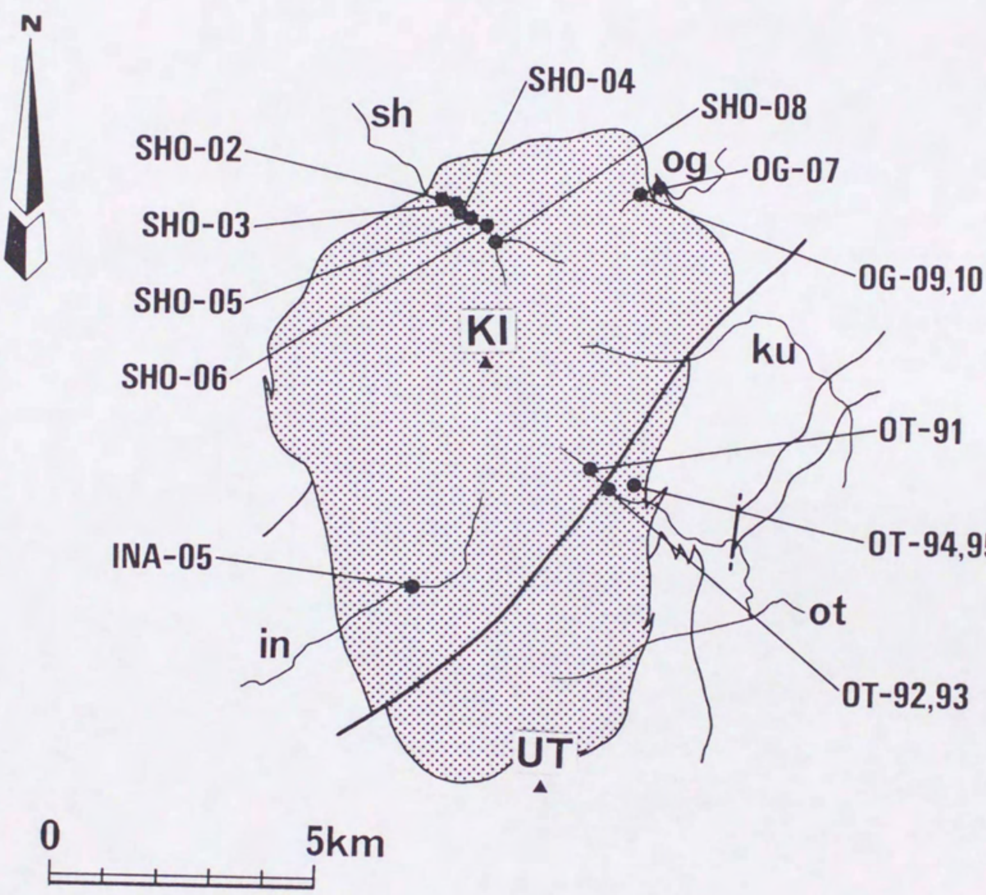


Fig.V-21 Sample localities of the Kisokoma granodiorite.
sh:Shozawa River, og:Oguro River, ku:Kurokawa River, ot:Otagiri River, in:Ina River.
KI:Kisokoma-ga-take mountain, UT:Utsugi-dake mountain.

Table V-9 Whole-rock chemical compositions of the Kisokoma granodiorite.

Sample No.	OT-95	OG-10	SHO-04	OT-92	SHO-08	SHO-05	OT-94	SHO-06	INA-05	OT-91	OG-08	OTK-20
SiO_2	51.77	54.33	55.51	60.68	62.84	63.12	63.35	63.36	63.44	63.90	64.53	64.87
TiO_2	1.18	0.74	0.99	0.69	0.67	0.63	0.63	0.63	0.62	0.68	0.57	0.58
Al_2O_3	16.81	15.70	17.10	16.62	15.95	15.95	16.01	16.22	16.10	15.68	16.21	15.34
FeO*	8.80	7.52	7.58	5.62	5.33	5.08	5.00	4.93	4.73	5.25	4.46	4.43
MnO	0.18	0.17	0.13	0.10	0.10	0.09	0.09	0.09	0.08	0.09	0.09	0.09
MgO	4.31	4.35	4.52	2.77	2.51	2.33	2.29	2.30	2.15	2.45	1.51	1.55
CaO	8.74	7.42	7.72	6.10	5.06	5.03	5.25	5.17	4.76	5.13	4.29	4.15
Na_2O	2.96	2.80	2.86	3.07	2.91	2.93	2.88	2.96	3.24	2.94	3.66	3.44
K_2O	1.22	3.86	1.67	1.52	2.38	2.25	1.89	2.20	2.07	1.69	2.12	2.40
P_2O_5	0.20	0.12	0.19	0.15	0.13	0.12	0.14	0.13	0.15	0.14	0.15	0.13
Total	96.16	97.01	98.27	97.32	97.88	97.53	97.53	97.97	97.34	97.93	97.60	96.98
Ba	427	1561	487	444	605	579	590	590		588		
Cu	25	26	24	9	3	n.d.	n.d.	3		6		
Cr	18	68	101	46	40	38		36		40		
Nb	15	6	8	7	8	8	7	8		9		
Ni	8	11	19	10	11	11	9	12		8		
Rb	39	129	63	51	82.7	79	64.0	76.5	78.0	77	77.3	80.8
Sr	360	288	383	383	322	327	360	334	331	332	348	332
V	194	161	150	108	91	89		85		91		
Y	37	27	18	22	23	22	21	21		19		
Zn	114	101	88	74	66	65	63	65		72		
Zr	121	107	150	165	145	152	151	156		147		

LOI: Loss on ignition, n.d.: not detected.

Table V-9 (continued).

Sample No.	SHO-03	OG-09	OG-07	SHO-02
SiO_2	65.38	66.54	66.99	67.09
TiO_2	0.57	0.47	0.48	0.47
Al_2O_3	15.89	15.78	15.52	16.05
FeO*	4.54	3.80	3.99	3.85
MnO	0.08	0.07	0.08	0.07
MgO	1.61	1.28	1.19	1.27
CaO	4.30	3.92	3.84	3.98
Na_2O	3.15	3.28	3.19	3.24
K_2O	2.42	2.37	2.44	2.51
P_2O_5	0.13	0.11	0.11	0.11
Total	98.06	97.62	97.83	98.64
Ba	677	602	610	612
Cu	n.d.	5	n.d.	n.d.
Cr	17	9	7	11
Nb	9	8	8	8
Ni	7	7	11	6
Rb	85	83	87.0	95.0
Sr	324	308	305	302
V	68	51	48	54
Y	24	23	24	24
Zn	66	57	58	57
Zr	182	158	169	166

Table V-10 Trace element concentrations and isotopic data of the Kisokoma granodiorite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
OT-95	39*	360*	0.3135	0.70946(1)				
OG-10	129*	288*	1.296	0.71065(1)				
SHO-04	63*	383*	0.4760	0.71025(1)				
OT-92	51*	383*	0.3853	0.70941(1)				
SHO-08	82.7	322	0.7447	0.70982(1)	4.51	22.8	0.1197	0.512183(11)
SHO-05	79*	327*	0.6991	0.70985(1)				
OT-94	64.0	360	0.5149	0.70973(1)	4.21	21.5	0.1185	0.512183(9)
SHO-06	76.5	334	0.6627	0.70979(1)				
OT-91	77*	332*	0.6712	0.70969(1)				
SHO-03	85*	324*	0.7592	0.71023(1)				
OG-09	83*	308*	0.7799	0.71035(1)				
OG-07	87.0	305	0.8267	0.71046(1)	4.88	26.7	0.1108	0.512152(10)
SHO-02	95.0	302	0.9097	0.71038(1)	5.30	30.3	0.1057	0.512162(10)
OTK-20	80.8	332	0.7051	0.71028(1)	5.00	21.30	0.1423	0.512174(11)
INA-05	78.0	331	0.6809	0.70993(1)	4.23	20.4	0.1255	0.512179(11)
INA-07	106	259	1.184	0.71060(1)				
OGW-02	115	242	1.375	0.71078(1)	5.29	29.3	0.1091	0.512177(11)
OG-08	77.3	348	0.6419	0.71039(1)	4.34	23.1	0.1135	0.512155(11)

*analyzed by XRF

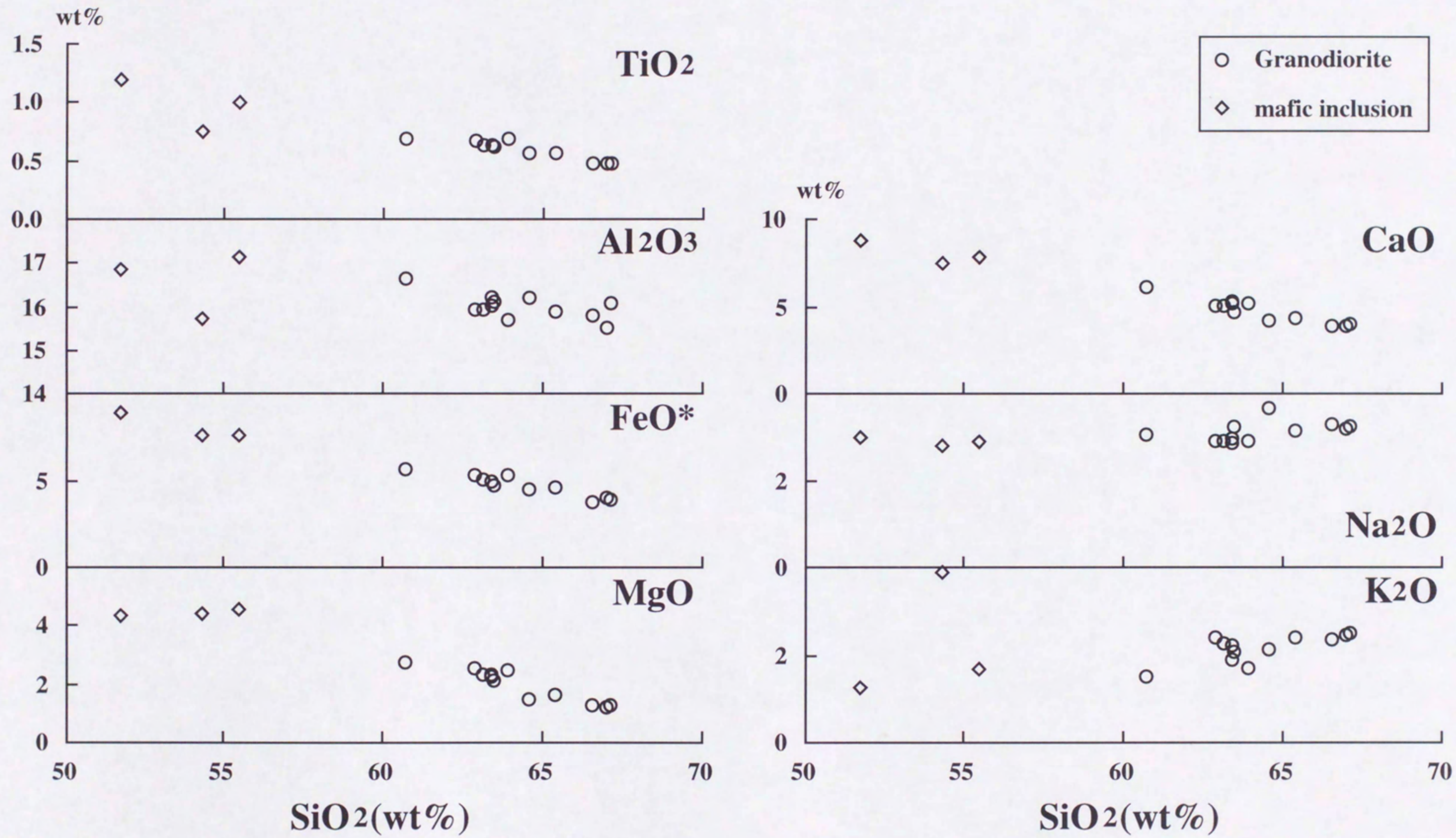


Fig.V-22 SiO2-oxides diagrams for the Kisokoma granodiorite.

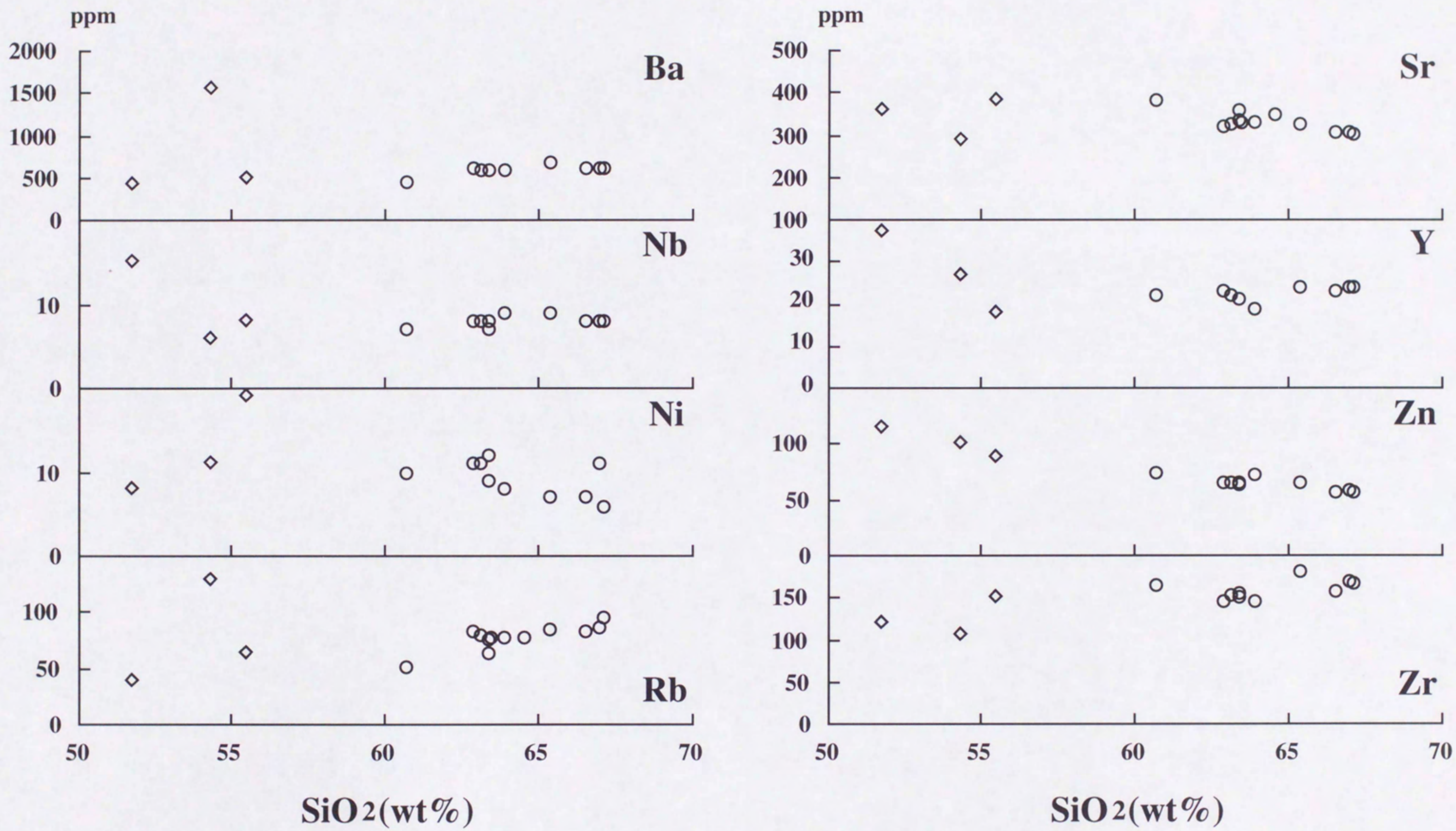


Fig.V-23 SiO2-minor element diagrams for the Kisokoma granodiorite.

samples disperse from the differentiation trend of the northern body between 65wt% of SiO_2 and 67% in SiO_2-MgO, CaO and K_2O diagrams.

The five samples, which are selected using the way shown in Figure V-1, from the northern body form an isochron indicating an age of 87.3±7.8Ma with a SrI of 0.70768±0.00020(Fig.V-20). The age can not be given from the samples of southern body, because the variations in $^{87}Sr/^{86}Sr$ ratios and $^{87}Sr/^{86}Sr$ ratios are small. These samples are not on the isochron of the northern body(Fig.V-20). However, the inclination of the arrangement of these samples is similar to one of the isochron from northern body. This suggests that the age of the southern body is similar to one of northern body. However SrI and NdI of the southern body corrected by 87.3Ma of the northern body are different from ones of latter(Table V-8). The samples, which might mix, are plotted between the isochron of the northern body and the southern body. This suggests that these rocks were formed by mixing of both bodies.

Kisokoma granodiorite

The Kisokoma granodiorite contains numerous mafic inclusions(Tsuchiya, 1967a,b). The sizes of these inclusions are variable from a few mm to dozens' cm. According to Tsuchiya(1967b), these mafic inclusions were formed as a gabbroic rock prior to the Kisokoma granodiorite, and were later included the subsequently formed Kisokoma granodiorite, and the metasomatic interactions took place between the granodiorite and the gabbroic inclusions. Thus, rocks of the Kisokoma granodiorite may be mixture of gabbroic inclusion and granodiorite.

Whole rock chemical compositions of samples from the Kisokoma granodiorite(Fig.V-21) are given in Table V-9. The Rb-Sr and Sm-Nd data are given in Table V-10.

SiO_2-oxides diagrams and SiO_2-minor element diagrams are given in Figures V-22 and 23. On these diagram, though there is a gap between

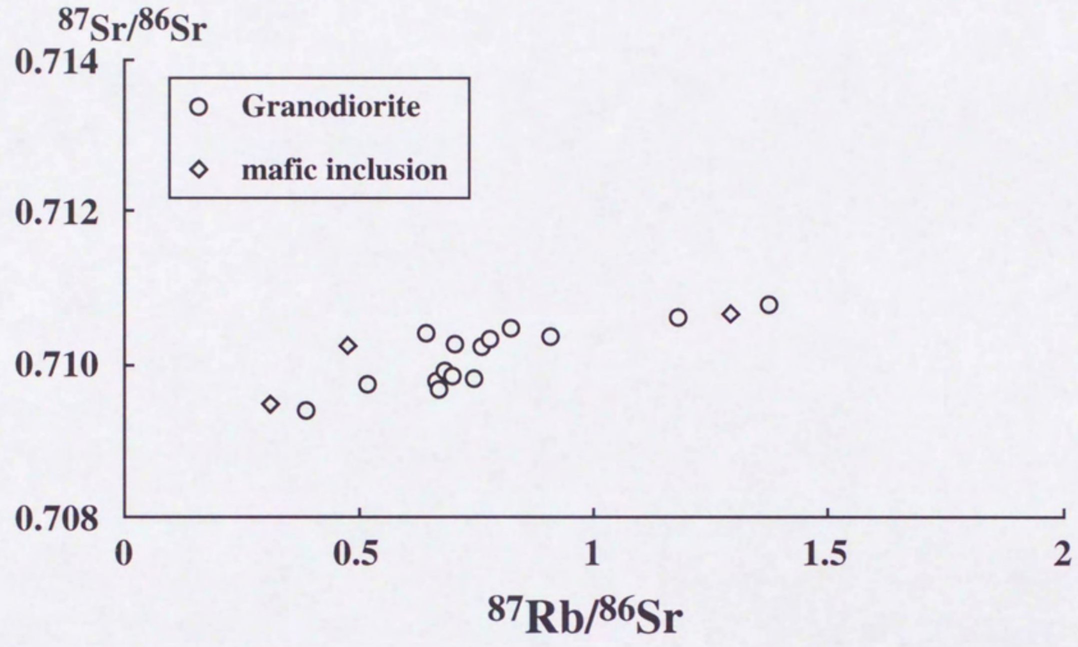


Fig.V-24 Rb-Sr whole-rock isochron diagram of the Kisokoma granodiorite.

SiO_2 contents of the Kisokoma granodiorites and mafic inclusions, mafic inclusions is on the extent of trend of the Kisokoma granodiorite in several elements. Thus, it is possible that trend of the Kisokoma granodiorite shows mixing line of them. The sample of OG-10 is rich in K_2O and Rb. This might be caused by formation of biotite by reaction with granodioritic magma. These samples of mafic inclusions belong to the biotite porphyritic facies or the biotite and plagioclase porphyritic facies by Tsuchiya(1967a). According to Tsuchiya(1967a), these facies were formed by interaction between gabbroic inclusion and granodioritic magma. The Rb-Sr whole-rock isochron diagram is shown in Figure V-24. An isochron can not be diffident because whole-rock samples disperse. These are plotted within the range surrounded by mafic inclusions. This is caused by mixing of gabbroic rocks and granodioritic magma.

To give a whole-rock isochron age of this body, it is necessary to investigate more samples that contain a rock including no mafic inclusions and mafic inclusions remained original texture and composition.

Metamorphic rock

Sr and Nd isotope ratios of some samples, which were collected from the zones II, III and IV, were analyzed. The Rb-Sr and Sm-Nd data are given in Table V-11.

The Rb-Sr and Sm-Nd isochron diagrams are shown in Figure V-25. The isochron can not be defined because the samples from all area disperse. The isochron can not be also defined in each area.

Migmatite

The Rb-Sr and Sm-Nd data of migmatite are given in Table V-12.

Result is shown in the isochron diagrams(Fig.V-26). An isochron can not be defined because all the whole-rock samples from migmatite disperse in Rb-Sr system. In Sm-Nd system, the isochron age can not be

Table V-11 Trace element concentrations and isotopic data of metamorphic rocks.

Sample No.	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
KU-04	2.662	0.72011(1)	6.26	33.0	0.1148	0.512084(10)
MIT-57	6.453	0.72273(1)	11.5	61.6	0.1133	0.512012(8)
ON-21	1.723	0.71739(1)	7.64	40.6	0.1137	0.512035(10)
SN-48	3.161	0.72121(1)	7.72	40.8	0.1142	0.512089(9)
MI(T)-44	2.254	0.72252(1)	6.37	33.1	0.1164	0.511953(13)
SN-13	2.837	0.72308(1)				
MI-14	1.880	0.71843(1)	7.69	41.1	0.1130	0.512038(9)
KU-27	2.602	0.71976(1)	6.79	36.6	0.1121	0.512078(10)
OS-01	2.893	0.72265(1)	6.83	35.6	0.1161	0.512019(9)
OT-32	2.938	0.72107(1)	6.29	32.9	0.1156	0.512057(11)
JI-10	1.988	0.72016(1)	6.68	34.7	0.1164	0.512043(10)
SN-26	2.764	0.72306(1)	6.31	33.4	0.1140	0.511943(10)
OTK-15	3.383	0.72108(1)	6.72	35.9	0.1131	0.512086(11)
KU-41	2.416	0.71765(1)	5.98	31.2	0.1159	0.512057(11)
KU-28	1.726	0.71775(1)	5.73	30.4	0.1140	0.512107(11)
KU-36	1.832	0.71968(1)	5.52	29.2	0.1143	0.512112(11)
KU-72	1.468	0.72110(1)	5.84	31.3	0.1128	0.511919(11)
INU-05	2.965	0.71879(1)	6.45	33.3	0.1171	0.512098(10)
OT-55	2.410	0.71992(1)	5.95	31.7	0.1134	0.512059(12)
NE-05	3.009	0.71827(1)	5.62	29.0	0.1171	0.512066(11)
OS-16	2.275	0.71820(1)	6.61	34.3	0.1165	0.512022(10)
NE-32	8.304	0.72515(1)	5.44	28.9	0.1139	0.512098(9)
NE-09	2.946	0.71631(1)	4.77	26.1	0.1101	0.512054(11)
OT-45	1.961	0.72213(1)	5.45	29.3	0.1124	0.511908(11)
NE-21	1.930	0.71704(1)	4.15	22.1	0.1137	0.512080(11)
OT-39	1.417	0.71870(1)	4.95	27.5	0.1089	0.511982(11)
NE-60	4.365	0.71759(1)	3.77	20.2	0.1130	0.512098(11)
TN-07	4.266	0.72148(1)	4.15	22.3	0.1124	0.512097(10)
ON-19a	4.345	0.72451(1)				
FU-13	0.5711	0.71725(1)	2.63	14.8	0.1074	0.512035(12)
OT-11	1.580	0.71759(1)	2.62	15.2	0.1042	0.511950(11)

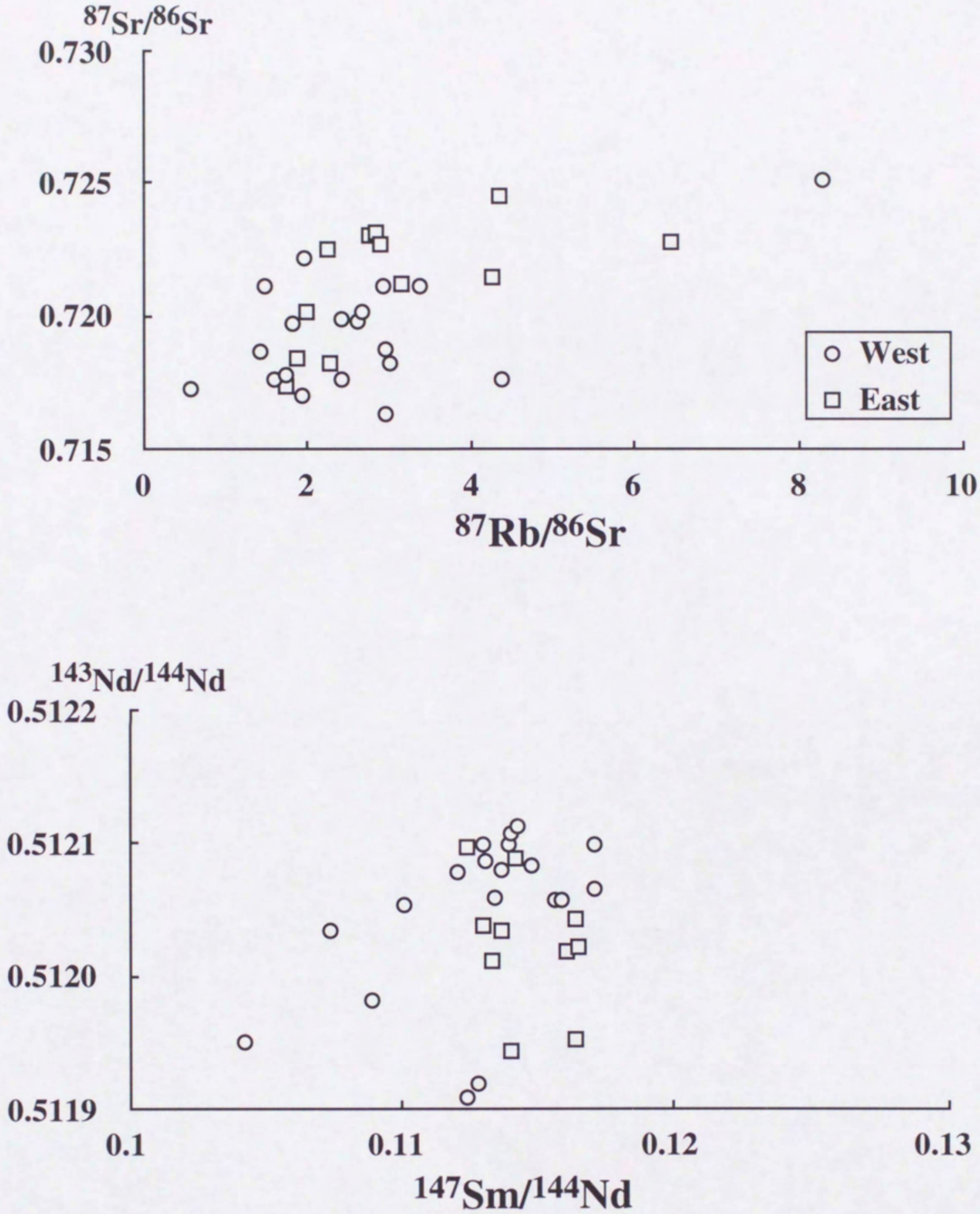
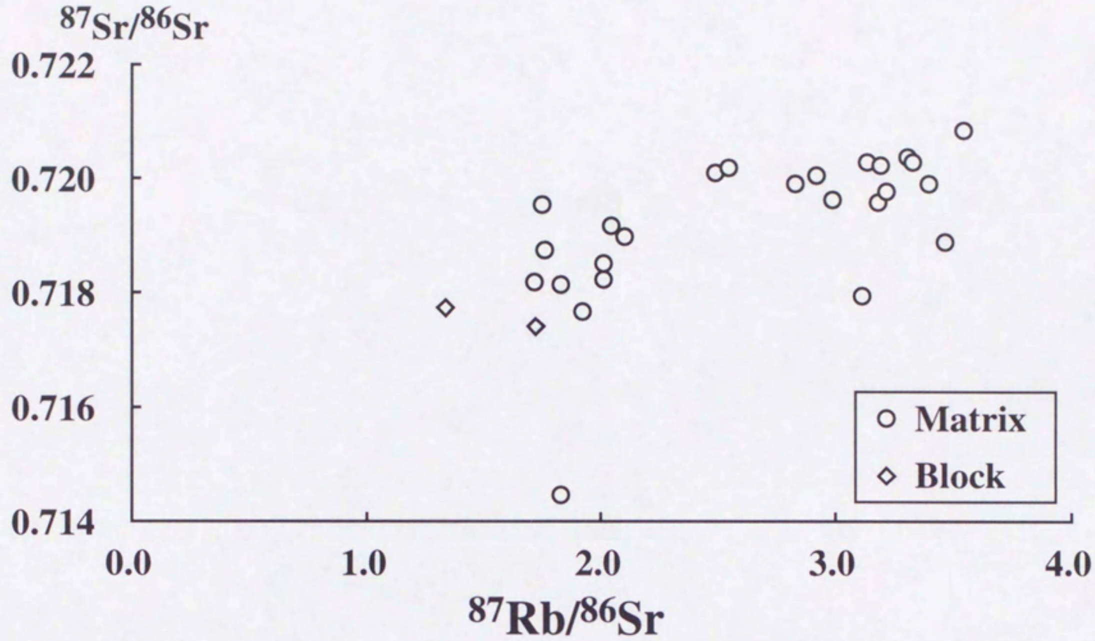


Fig.V-25 Rb-Sr and Sm-Nd whole-rock isochron diagrams for the metamorphic rocks.
West:the area west of the Komagane City, East:the area east of the Tenryu River.

Table V-12 Trace element concentrations and isotopic data of the migmatite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
TNH-01	170*	142*	3.462	0.71889(1)	4.29	22.8	0.1141	0.512053(13)
TNH-02	144*	207*	2.014	0.71824(1)	4.23	22.4	0.1140	0.512038(7)
TNH-03	142*	214*	1.922	0.71767(1)				
TNH-04	109*	234*	1.343	0.71773(1)	5.05	26.8	0.1138	0.512052(8)
TNH-06	128*	202*	1.833	0.71815(1)	5.32	27.9	0.1153	0.512073(9)
TNH-07	195*	222*	2.543	0.72018(1)	5.23	28.0	0.1129	0.512084(7)
TNH-08	40*	181*	0.6348	0.71863(1)				
ON-20	125*	211*	1.718	0.71820(1)				
ON-21	146*	245*	1.723	0.71739(1)				
ON-22	137*	197*	2.007	0.71852(1)				
KI-02	147*	202*	2.107	0.71897(1)	5.98	32.4	0.1116	0.512053(11)
JI-11	157*	183*	2.493	0.72011(1)				
JI-13	141*	199*	2.048	0.71914(1)				
JI-14	172*	141*	3.551	0.72084(1)				
JI-24	165	144	3.311	0.72038(1)	5.90	31.6	0.1127	0.512069(12)
JI-25	157	156	2.916	0.72005(1)	5.03	26.8	0.1133	0.512067(11)
JI-26	150	154	2.833	0.71993(1)	5.90	32.1	0.1111	0.512066(9)
JI-27	155	143	3.141	0.72026(1)	5.78	31.5	0.1108	0.512087(10)
JI-28	169	147	3.329	0.72026(1)	7.13	38.4	0.1123	0.512047(11)
JI-29	144	140	2.985	0.71964(1)	5.64	29.9	0.1139	0.512073(8)
JI-30	85.7	140	1.767	0.71876(1)	5.46	29.5	0.1120	0.512164(10)
JI-31	181	168	3.111	0.71794(1)	6.34	34.3	0.1117	0.512028(11)
JI-33	156	141	3.194	0.72021(1)	5.92	32.0	0.1119	0.512075(10)
JI-34	162	138	3.403	0.71990(1)	5.70	30.5	0.1129	0.512074(9)
JI-35	149	134	3.214	0.71979(1)	6.42	34.8	0.1113	0.512077(10)
TN-36	119*	198*	1.746	0.71954(1)				
TN-43	178*	281*	1.832	0.71445(1)				
WAM-01	176*	160*	3.178	0.71959(1)				

*analyzed by XRF.



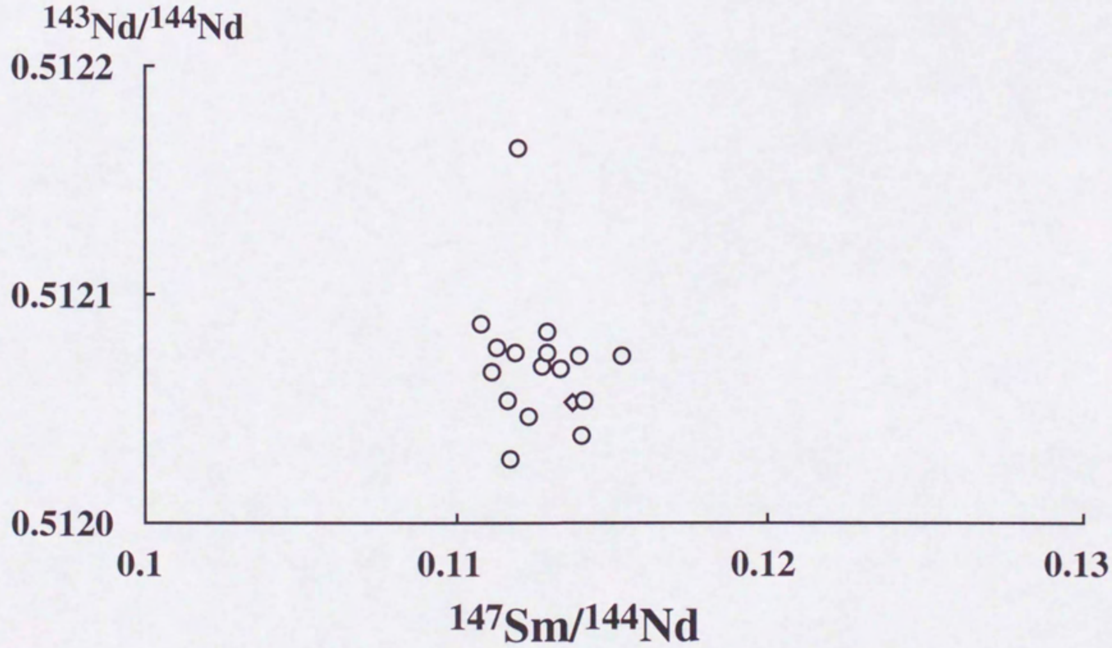


Fig.V-26 Rb-Sr and Sm-Nd whole-rock isochron diagrams for the migmatite.

given too. These suggest that isotopic homogenization that extended all over the body could not take place at the time of formation of migmatite. This might be caused by partially formation of melt, and mixing of melt and metamorphic rocks with various rates.

Kamihara tonalite

Kamihara tonalite occurs as concordant sheets in the Ryoke metamorphic rocks(Sakakibara, 1967; Kagami, 1968; Kutsukake, 1970, 1977). This is fine to medium grained and a conspicuously gneissic rock. The main mineral assemblage is plagioclase, quartz, biotite and hornblende with minor amounts of K-feldspar and cummingtonite. The samples analyzed in this study are exposed in the Toyone Village and Lake Sakuma area(Kutsukake, 1993). Particular petrography of this tonalite is described in Kutsukake(1993).

Sr and Nd isotope ratios of six samples from this tonalite are analyzed. The Rb-Sr and Sm-Nd data are given in Table V-13. Whole rock chemical compositions of these samples were given in Table 2a of Kutsukake(1993).

Sr concentrations of the sample of KVII and KVIII differ from other samples. These samples are excluded from the regression. The four samples that are on the differentiation trend of all element form an isochron indicating an age of 93.4±5.1Ma with a SrI of 0.70749±0.00006(Fig.V-27). However it is necessary to do more detailed studies.

Gabbro

Three gabbroic masses, Inoshikori, Tashika and Ohata mass, occur in the Toyone Village, Aichi Prefecture(Kutsukake, 1974).

The Ohata mass, which occurs in the Tenryukyo granite, mainly composed of pyroxene-hornblende gabbro and hornblende gabbro(Kutsukake, 1974).

Table V-13 Trace element concentrations and isotopic data of the Kamihara tonalite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)	NdI*
KII	57.1	276	0.5990	0.70830(1)				0.512373(10)	
KIII	55.0	279	0.5703	0.70824(1)	12.1	44.6	0.1635	0.512384(8)	0.512284
KV	90.6	274	0.9566	0.70874(1)				0.512377(9)	
KVI	106	252	1.220	0.70912(1)	4.76	27.3	0.1055	0.512322(10)	0.512258
KVII	67.6	362	0.5401	0.70806(1)				0.512335(10)	
KVIII	90.8	354	0.7416	0.70742(1)				0.512410(10)	

*corrected by Rb-Sr whole-rock isochron age:93.4Ma.

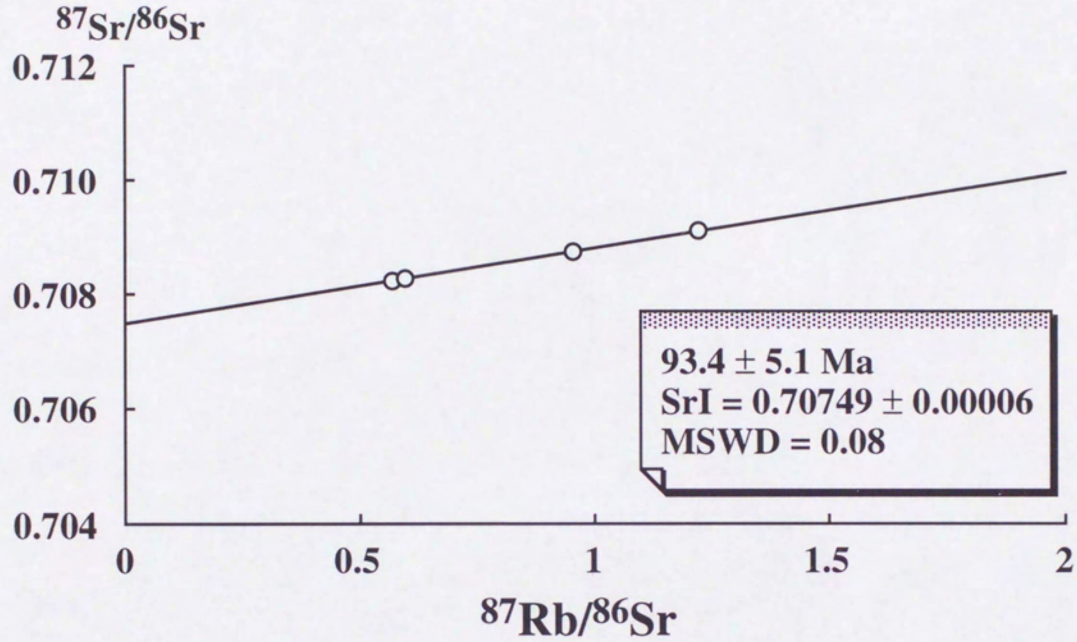


Fig.V-27 Rb-Sr whole-rock isochron for the Kamihara tonalite.

Five samples were collected from this mass(Fig.V-28). The Rb-Sr and Sm-Nd data are given in Table V-14.

These samples form an isochron indicating an age of 87±42Ma with SrI=0.70762±0.00010(Fig.V-29). However this isochron has large error. It is not certain whether this isochron is pseudo-isochron or resetting age at present. In Sm-Nd system, the age can not be given because the variations in $^{143}Nd/^{144}Nd$ and $^{147}Sm/^{144}Nd$ ratios are small.

The Inoshikori mass occurs in metamorphic rocks in sillimanite zone, and is intruded by the Kamihara tonalite(Kutsukake, 1974). This mass is composed of several rock types, ranging from olivine norite to quartz gabbro through norite and hornblende norite. They would be formed through the fractional crystallization of noritic magma.

The two samples were collected from the Inoshikori mass. The Rb-Sr and Sm-Nd data are given in Table V-14. In both of Rb-Sr system and Sm-Nd system, isochron age can not be given.

Aji granite

The Aji granite is fine to medium grained massive biotite granite exposed in the Yashima and the Aji Peninsula, the Shikoku(Kutsukake et al., 1979). This is composed of K-feldspar, plagioclase, quartz, biotite with accessory allanite, apatite, zircon and sphene, and rarely is hornblende bearing. K-Ar biotite age of 80Ma(Kawano and Ueda, 1966) has reported about this body.

Nine samples were collected from this body(Fig. V-30).

Whole rock chemical compositions of these samples are given in Table V-15. The Rb-Sr and Sm-Nd data are given in Table V-16.

SiO_2-oxides diagrams and SiO_2-minor elements diagram are given in FiguresV-31 and 32. The six samples, which are on the differentiation trend of all element, form an isochron indicating an age of 88±17Ma with a SrI of 0.70769±0.00015(Fig.V-33).

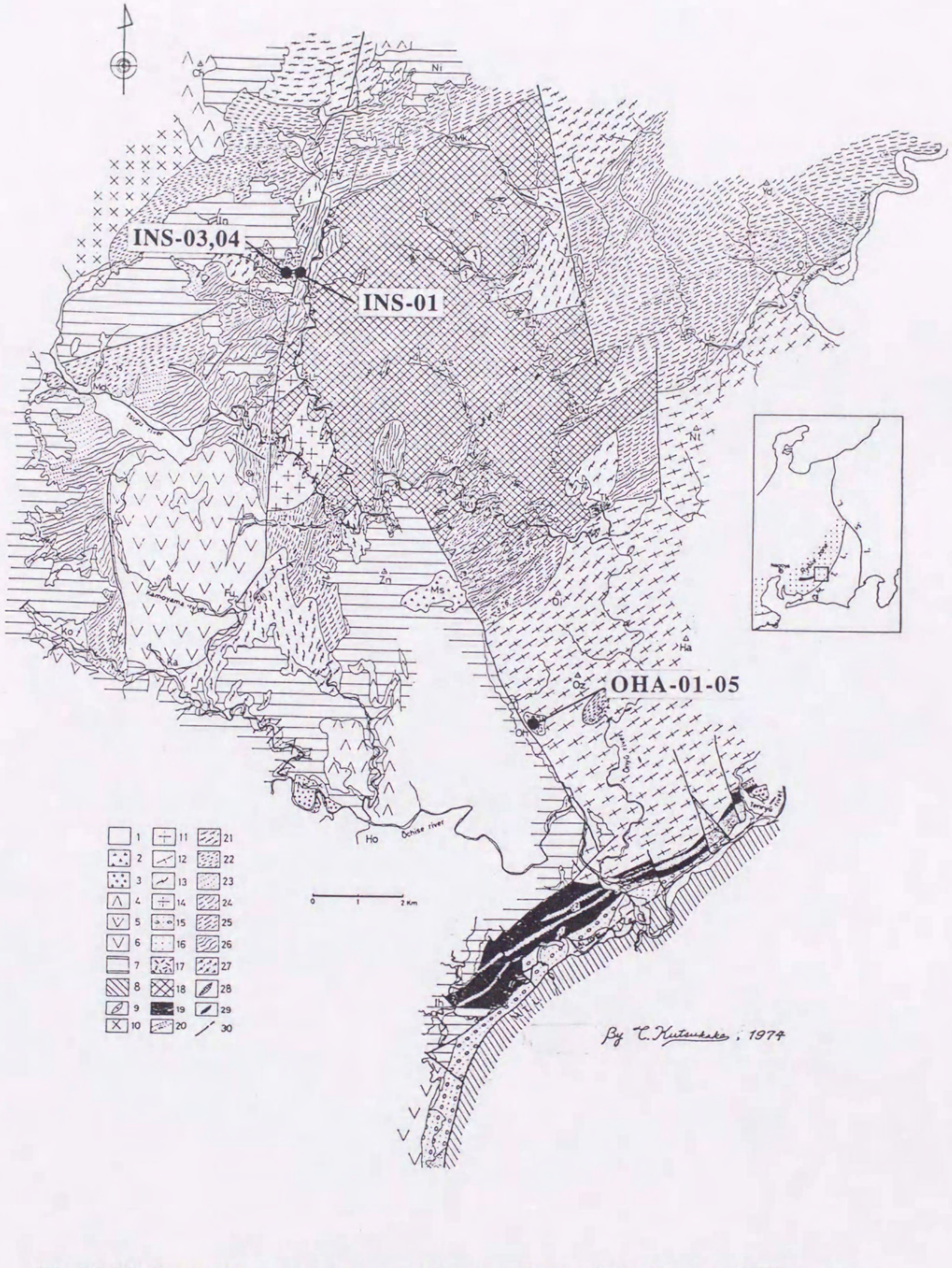


Fig.V-28 Geological map and sampling localities of the Toyone Village area. (after Kutsukake, 1976)

Fig.V-28 Geological map and sampling localities of the Toyone Village area(after Kutsukake, 1976).

1: Alluvium, 2: Debris, 3: Terrace deposit, 4: Basalt and andesite, 5: Dacite, 6: Rhyolite, 7: Tertiary sediments, 8: Sambagawa schists, 9: Busetsu granite, 10: Inagawa granite, 11: Mitsuhashi granite, 12: Tenryukyo granodiorite, 13: Kamihara tonalite, 14: Fine-grained biotite granodiorite, 15: Mylonite, 16: "Hälleflinta", 18: Metabasite, 19: Hornfels (pelitic and psammitic), 20: Hornfels derived from chert, 21: Mica schist (pelitic), 22: Mica schist (psammitic), 23: Quartz schist, 24: Gneiss (pelitic), 25: Gneiss (psammitic), 26: Quartz gneiss, 27: Nebulitic gneiss, 28: Metamorphic rock derived from "Schalstein", 29: Marble, 30: Fault.

M.T.L.: Median Tectonic Line, I.S.L.: Itoigawa-Shizuoka Line.

Locality name As: Asakusa, Ch: Chausu-yama, Fu: Futto, Ha: Hanare-yama, Ho: Hongo, Hy: Hiyosawa, Ih: Ichihara, In: Inoshikori, Ka: Kami-Awashiro, Ko: Kobayashi, Kt: Kakinotaira, Ky: Kashiyage, Md: Midashi, Mk: Makinoshita, Ms: Misono, Ni: Niino-toge, Ns: Naka-Shitara, Nt: Nihon-katsuka-yama, Od:Odachi, Oh: Ohata, Oi: Oiwa-dake, Os: Osawa, Ot: Otani, Oz; Ozasa-yama, Sk: Shimo-Kurokawa, So: Sogawa, Su: Sakauba, Tk: Tashika, Ts: Tsugawa, Tw: Tawagane-toge, Uk: Urakawa, Ur: Ure, Us: Urushijima, Yd: Yatsudake-yama, Zn: Zinno-yama.

Table V-14 Trace element concentrations and isotopic data of the gabbroic rocks.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
Ohata mass								
OHA-01	35.2	382	0.2665	0.70798(1)	3.60	13.7	0.1570	0.512302(13)
OHA-02	3.43	409	0.02432	0.70767(1)	0.683	2.70	0.1531	0.512327(13)
OHA-03	12.7	462	0.07934	0.70778(1)	2.40	9.51	0.1527	0.512312(13)
OHA-04	28.5	387	0.2127	0.70787(1)	1.15	3.39	0.2051	0.512346(14)
Hornblende	4.21	29.1	0.4191	0.70813(1)	0.576	1.69	0.2058	0.512390(14)
Felsic fraction	40.4	850	0.1375	0.70780(1)				
OHA-05	11.9	425	0.08095	0.70764(1)	2.32	8.55	0.1642	0.512344(12)
Hornblende	1.32	18.6	0.20520	0.70778(1)	0.822	2.59	0.1918	0.512374(10)
Felsic fraction	13.8	771	0.05163	0.70761(1)	0.885	4.50	0.1190	0.512369(20)
Inoshikori m.								
INS-03	20.7	222	0.2703	0.70790(1)	1.33	5.48	0.1471	0.512329(12)
INS-04	14.8	279	0.1533	0.70808(1)	1.33	5.51	0.1456	0.512264(11)

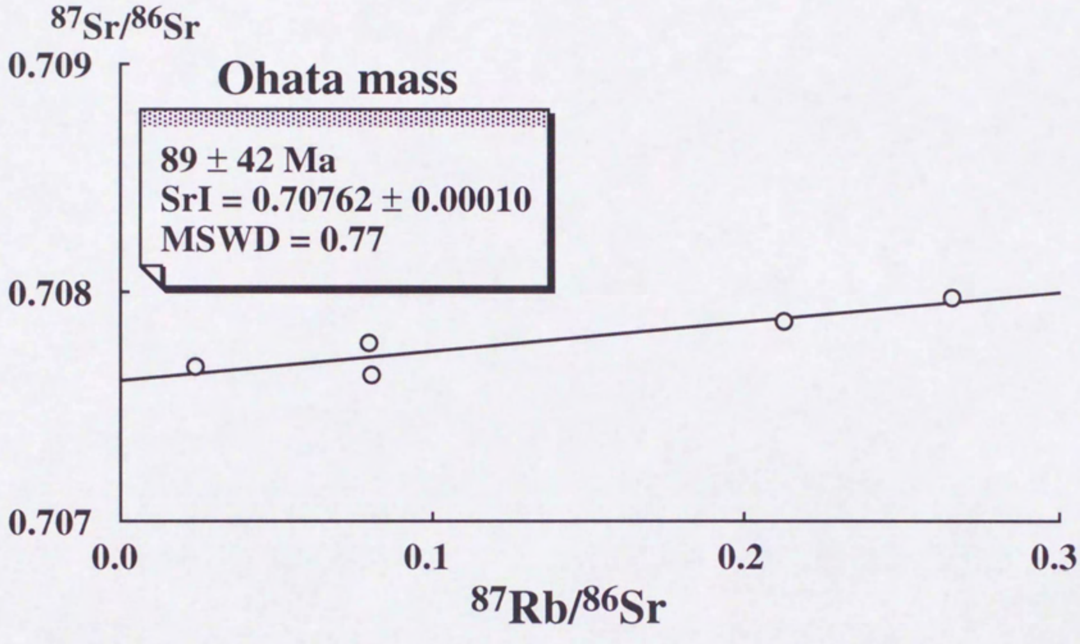


Fig.V-29 Rb-Sr whole-rock isochron for the Ohata mass.

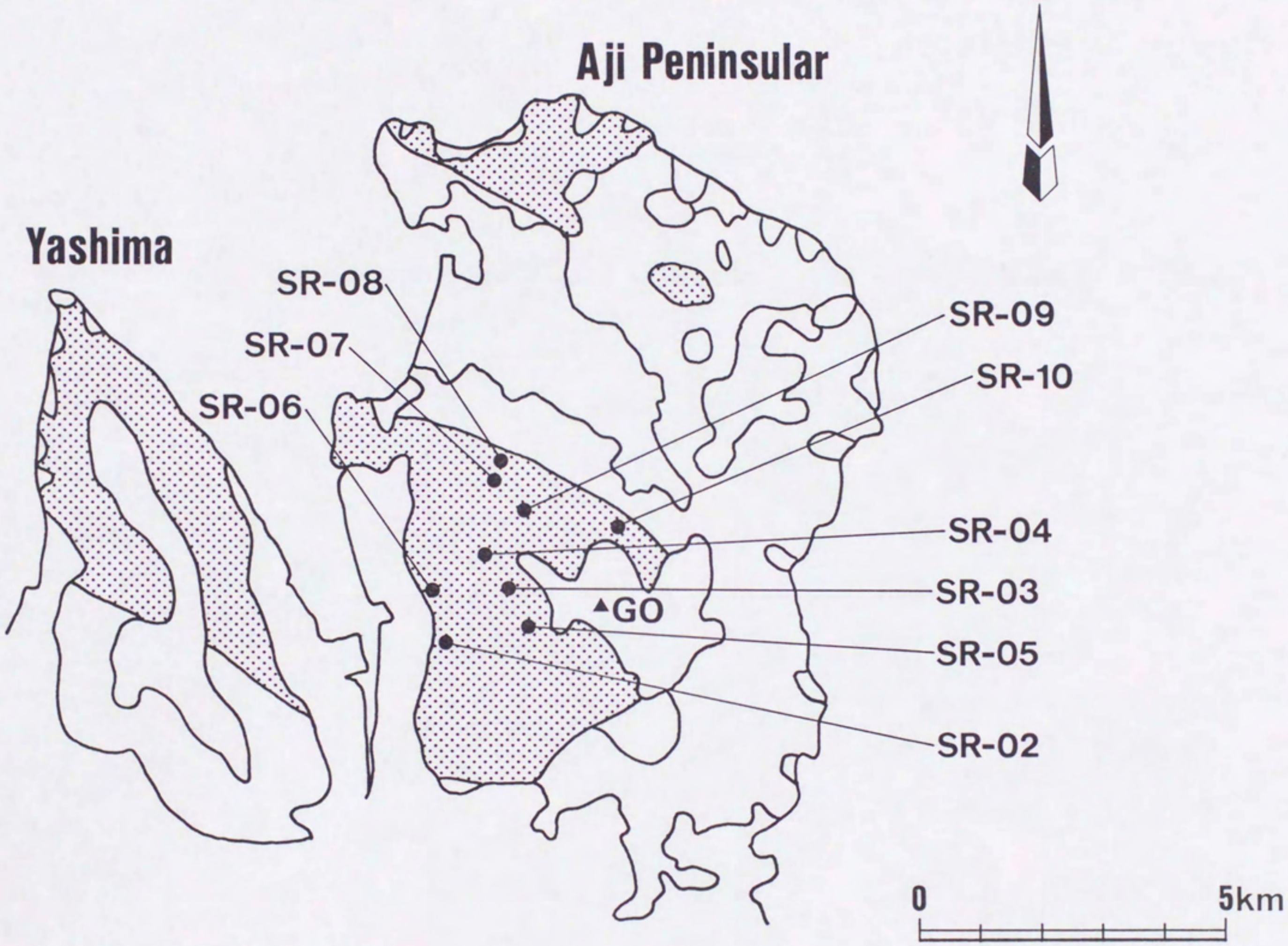


Fig.V-30 Sample localities of the Aji granite (partly modified from Kutsukake et al., 1979). GO: Goken-zan mountain.

Table V-15 Whole-rock chemical compositions of the Aji granite.

Sample No.	SR-05	SR-02	SR-10	SR-04	SR-06	SR-03	SR-09	SR-07	SR-08
SiO_2	69.30	69.95	69.99	70.47	70.98	71.53	72.34	72.37	72.97
TiO_2	0.35	0.39	0.35	0.32	0.24	0.29	0.25	0.27	0.24
Al_2O_3	16.45	16.55	15.88	16.69	16.08	15.78	15.71	15.84	15.56
FeO*	2.35	2.59	2.58	2.08	2.22	2.17	1.99	2.02	1.93
MnO	0.06	0.06	0.06	0.05	0.06	0.06	0.05	0.06	0.05
MgO	0.71	0.86	0.94	0.68	0.47	0.59	0.56	0.61	0.56
CaO	2.67	2.79	2.84	2.73	2.44	2.47	2.13	2.17	2.11
Na_2O	3.74	3.80	3.48	3.93	3.69	3.66	3.78	3.59	3.59
K_2O	2.67	2.47	3.08	2.65	2.94	2.76	3.10	3.11	3.38
P_2O_5	0.11	0.10	0.09	0.09	0.08	0.09	0.08	0.09	0.07
Total	98.40	99.55	99.29	99.69	99.18	99.39	100.00	100.15	100.46

Table V-16 Trace element concentrations and isotopic data of the Aji granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)	NdI*
SR-05	71.1	369	0.5577	0.70845(1)					
SR-02	55.5	404	0.3976	0.70816(1)	3.48	19.1	0.1105	0.512342(20)	0.512278
SR-10	85.8	285	0.8703	0.70866(1)					
SR-04	59.6	426	0.4053	0.70791(1)					
SR-06	63.2	360	0.5081	0.70832(1)	3.54	19.0	0.1129	0.512327(44)	0.512262
SR-03	64.5	340	0.5484	0.70840(1)	4.00	22.2	0.1090	0.512341(26)	0.512278
SR-09	77.7	317	0.7079	0.70863(1)					
SR-07	78.4	324	0.6998	0.70856(1)					
SR-08	83.5	302	0.8005	0.70862(1)					

*corrected by Rb-Sr whole-rock isochron age:88Ma.

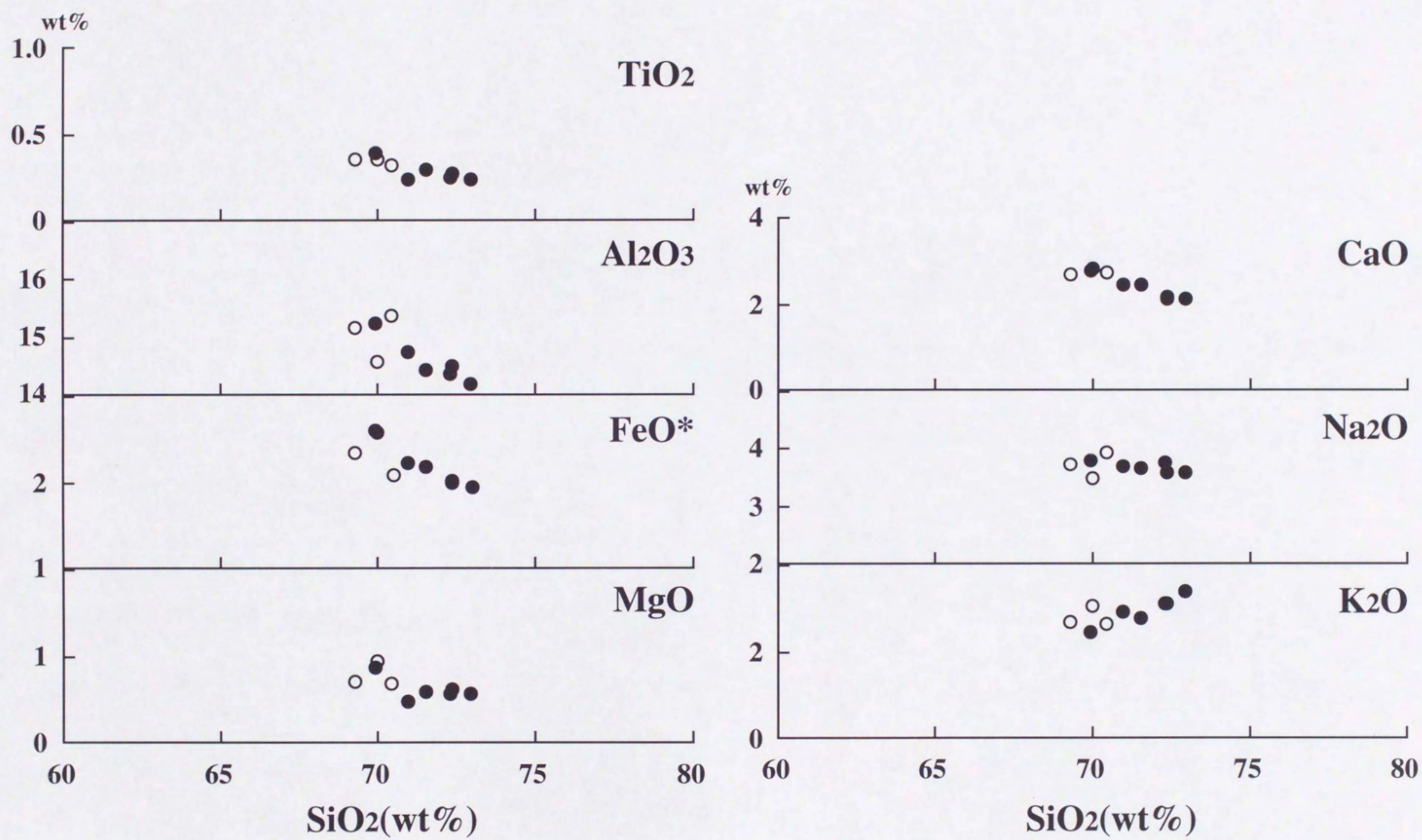


Fig.V-31 SiO_2-oxides diagrams for the Aji granite.

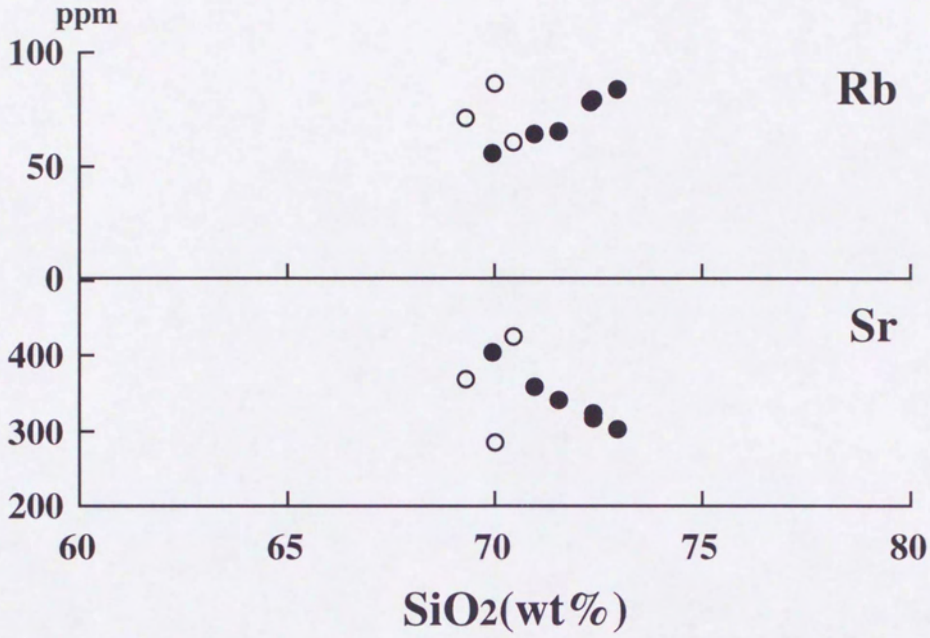


Fig.V-32 SiO_2-minor element diagrams for the Aji granite.

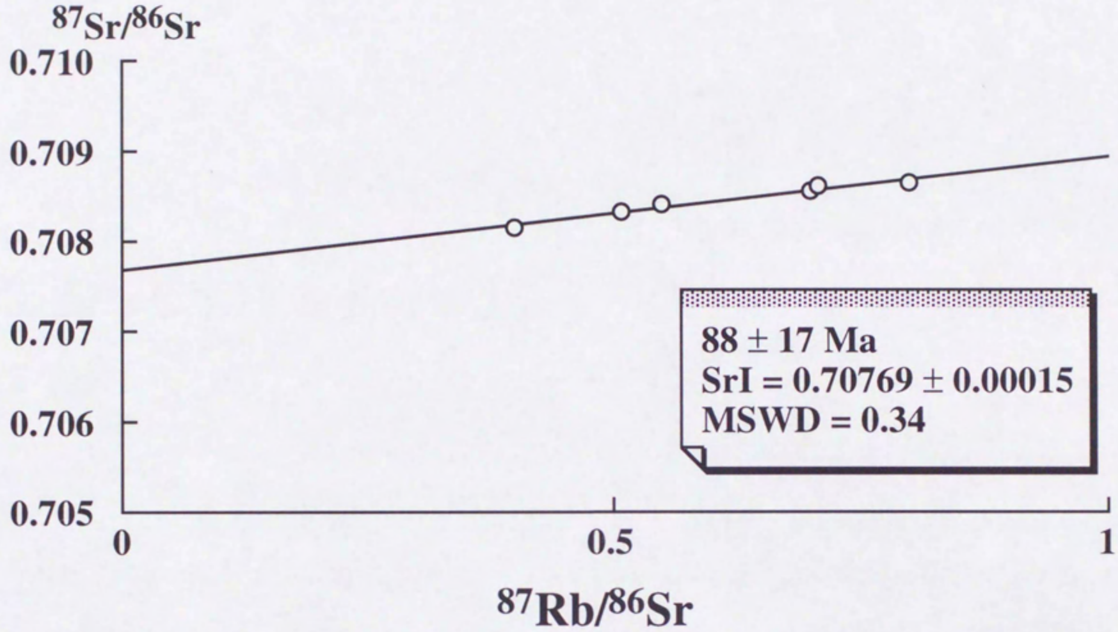


Fig.V-33 Rb-Sr whole-rock isochron for the Aji granite.

C. Rb-Sr whole-rock and mineral isochron age

Otagiri granite

Biotite, muscovite and felsic fraction(mixture of plagioclase, quartz, K-feldspar) were separated from the two samples, INU-20 and NAK-50 by flotation, and isodynamic separation. Biotite and felsic fraction were separated from OT-88 that was collected from same locality of OT-01. Accessory minerals (e.g. apatite with high REE content) were not totally excluded from these fractions. The Rb-Sr and Sm-Nd data are given in Table V-17.

Biotite, felsic fraction and a whole-rock sample from INU-20 define a Rb-Sr whole-rock and mineral isochron age of 52.2±0.5Ma(Fig.V-34). Muscovite separated from INU-20 do not plot on this whole-rock and mineral isochron, but gives Rb-Sr whole-rock and muscovite isochron age of 67.5±0.04Ma(Fig.V-34). Biotite, felsic fraction and a whole-rock sample from OT-88 define an isochron age of 54.7±0.5Ma(Fig.V-34). Biotite, felsic fraction and a whole-rock sample from NAK-50 define an isochron age of 54.6±0.4Ma(Fig.V-34). Muscovite separated from this sample is plotted on this isochron.

Katsuma quartzdiorite

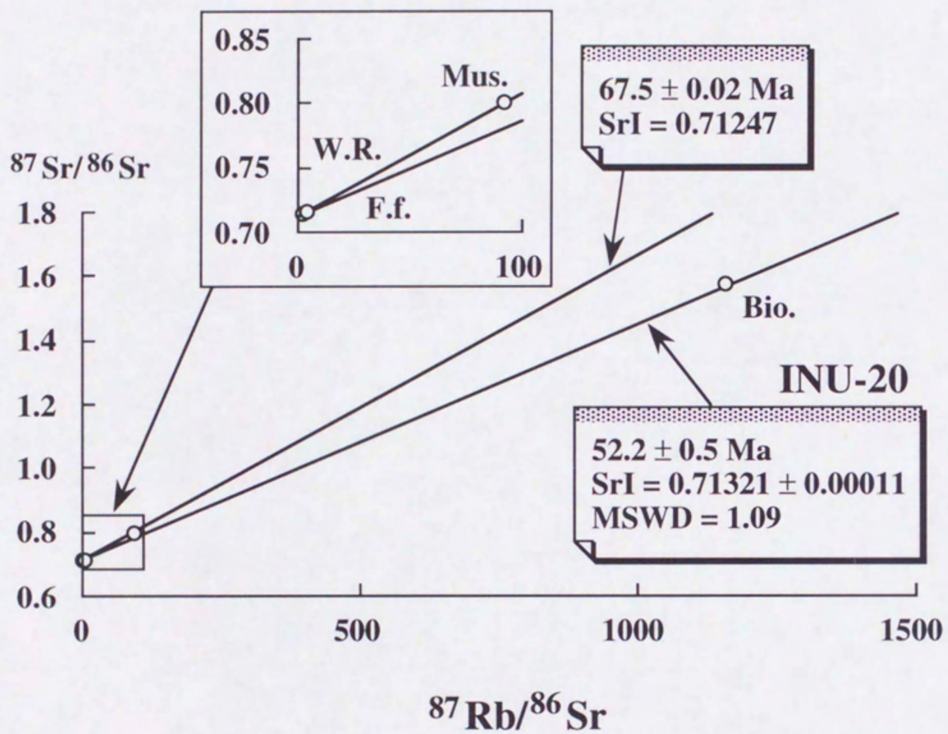
Biotite, hornblende and felsic fraction were separated from the four samples, ON-27, ON-29, OS-11 and NA-03, respectively.

The Rb-Sr and Sm-Nd data are given in Table V-14.

Mineral samples and a whole-rock sample define a Rb-Sr whole-rock and mineral isochron age of 62.7±0.7Ma(ON-27), 61.7±0.8Ma(ON-29), 60.9±0.2Ma(OS-11) and 57.9±0.3Ma(NA-03), respectively(Fig.V-35). On the other hand, hornblendes do not plot on these isochrons. In the Sm-Nd system, the age can not be given, because $^{143}Nd/^{144}Nd$ ratios of minerals agree with each other in the range of error.

Table V-17 Trace element concentrations and isotopic data of the Otagiri granites.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd
INU-20								
Biotite	1096	2.96	1162	1.57362(5)	12.6	82.5	0.09243	0.511935(17)
Muscovite	506	16.1	91.62	0.80030(2)				
Felsic f.	130	200	1.884	0.71455(1)	1.12	6.51	0.1041	0.511929(12)
OT-88	49.1	515	0.2758	0.71075(1)	5.56	29.8	0.1127	0.512137(11)
Biotite	284	13.3	62.30	0.75892(2)				
Felsic f.	10.3	592	0.0505	0.71055(1)				
NAK-50								
Biotite	588	9.71	177.6	0.84853(2)	24.2	132	0.1110	0.512265(10)
Muscovite	366	17.3	61.54	0.75768(2)	6.66	32.8	0.1228	0.512263(14)
Felsic f.	115	137	2.416	0.71257(1)				



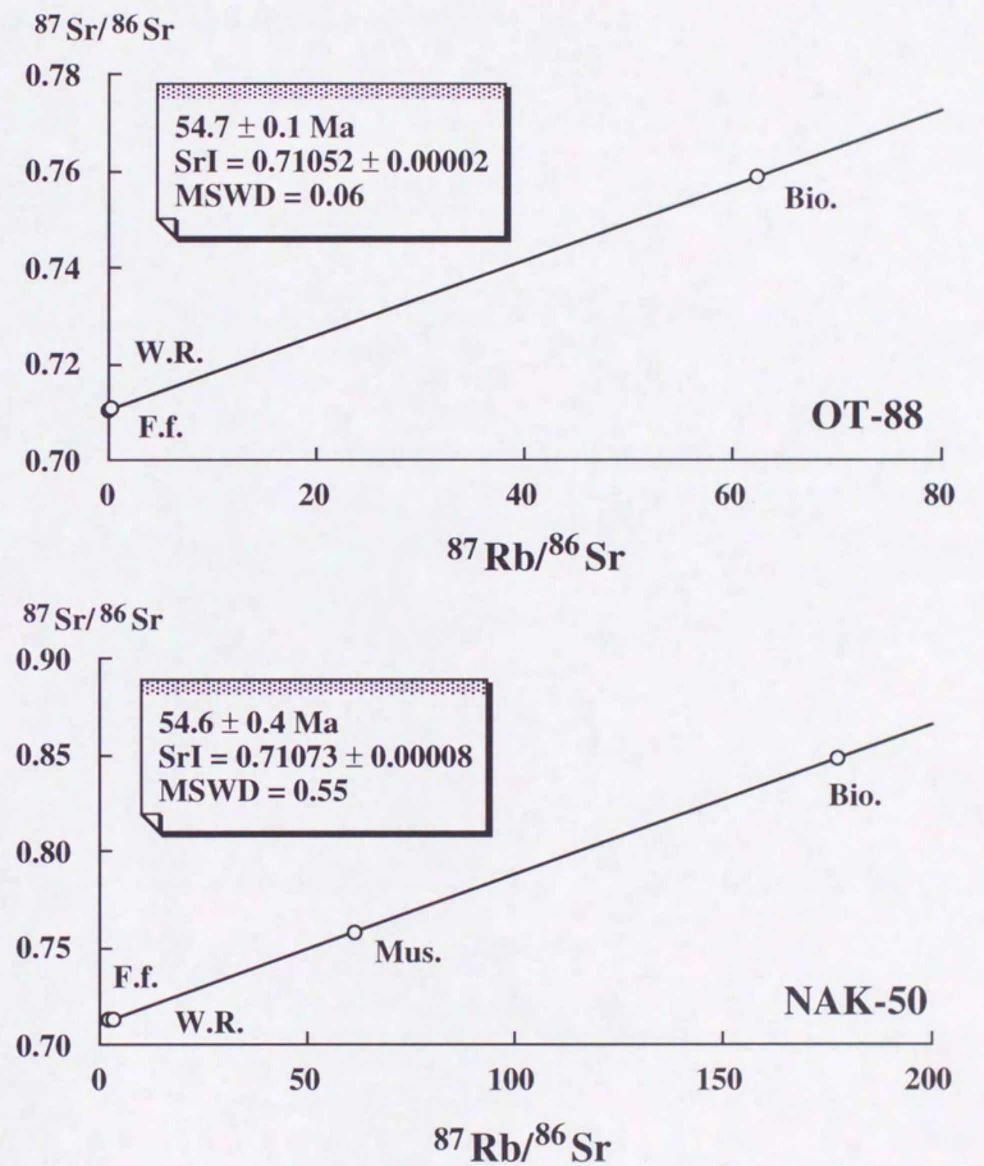


Fig.V-34 Rb-Sr whole-rock and mineral isochrons for the Otagiri granites.
Bio:biotite, Mus:muscovite, F.f.:felsic fraction, W.R.:whole-rock.

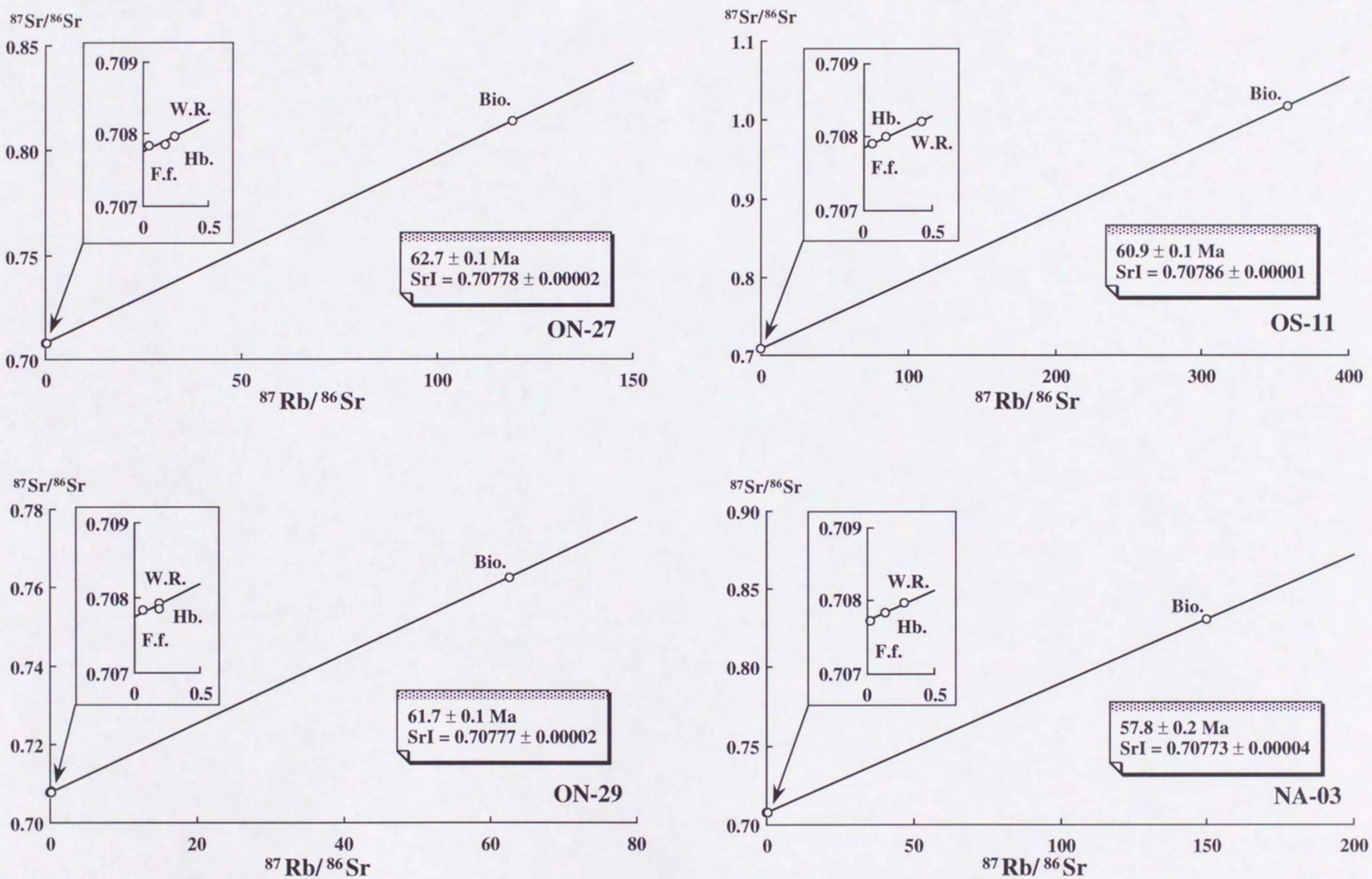


Fig.V-35 Rb-Sr whole-rock and mineral isochrons for the Katsuma quartzdiorite.
Bio: biotite, F.f.: felsic fraction, Hb: hornblende, W.R.: whole-rock.

Ichida granite

Biotite and felsic fraction were separated from the seven samples, respectively.

The Rb-Sr and Sm-Nd data of these samples are given in Table V-18.

Mineral samples and a whole-rock sample define an Rb-Sr whole-rock and mineral isochron ages of 57.0±0.5Ma(YO-01), 53.5±0.1Ma(KAT-07), 48.8±0.1Ma(KAT-08), 58.9±0.5Ma(OSI-03), 56.9±0.1Ma(OSI-04), 58.1±0.1Ma(OSI-05) and 51.8±0.7Ma(OSI-06), respectively(Figs.V-36 and 37). In the Sm-Nd system, the age can not be given, because the variations in $^{143}Nd/^{144}Nd$ and $^{147}Sm/^{144}Nd$ ratios are small.

Takato granite

The Rb-Sr and Sm-Nd data of these samples are given in Table V-19.

Mineral samples and a whole-rock sample define Rb-Sr whole-rock and mineral isochron age of 57.7±0.1Ma(TAN-05), 84.1±0.2Ma(INO-04), 59.3±0.3Ma(MI-17), 53.6±0.1Ma(TAN-27), 59.3±0.6Ma(MI-22), respectively(Fig.V-38 and 39). In the Sm-Nd system, the age can not be given, because the variations in $^{143}Nd/^{144}Nd$ and $^{147}Sm/^{144}Nd$ ratios are small.

Hiji quartzdiorite

The Hiji quartzdiorite in study area is deformed and has a compositional layering with a thickness of about several cm. Then, two samples having a compositional layering, MU-02 and ON-33, were taken from the Hiji quartz diorite. The sample MU-02 is divided into seven whole-rock samples(MU-02A-G), which were collected from each different layer, as shown in Figure V-40 . The sample ON-33 is divided into four whole-rock samples(ON-33A-D). Biotite, hornblende and felsic fraction were separated from ON-33.

The Rb-Sr and Sm-Nd data are given in Table V-20.

Table V-18 Trace element concentrations and isotopic data of the Ichida granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd
YO-01								
Biotite	321	10.8	86.42	0.77857(1)	1.45	5.56	0.1577	0.512322(24)
Felsic f.	21.0	582	0.1042	0.70868(1)	0.277	1.38	0.1212	0.512263(14)
KAT-07								
Biotite	406	9.37	126.6	0.80475(2)				
Felsic f.	24.2	467	0.1502	0.70866(1)				
OSI-04								
Biotite	360	11.2	93.94	0.78448(1)				
Felsic f.	23.0	431.0	0.1545	0.70866(1)				
OSI-03								
Biotite	499	5.96	247.0	0.91515(3)				
Felsic f.	23.20	344	0.19470	0.70862(1)				
OSI-05								
Biotite	404	10.2	115.3	0.80363(1)	0.900	2.60	0.2093	0.512301(23)
Felsic f.	26.2	415	0.1826	0.70862(1)	0.206	1.04	0.1201	0.512264(14)
OSI-06								
Biotite	494	5.90	246.7	0.89018(1)	2.09	11.9	0.1062	0.512237(24)
Felsic f.	45.0	349	0.3733	0.70883(1)	0.325	1.93	0.1020	0.512235(13)
KAT-08								
Biotite	637	5.89	320.1	0.93087(2)				
Felsic f.	76.9	239	0.9297	0.70971(1)	1.56	9.01	0.1046	0.512243(14)

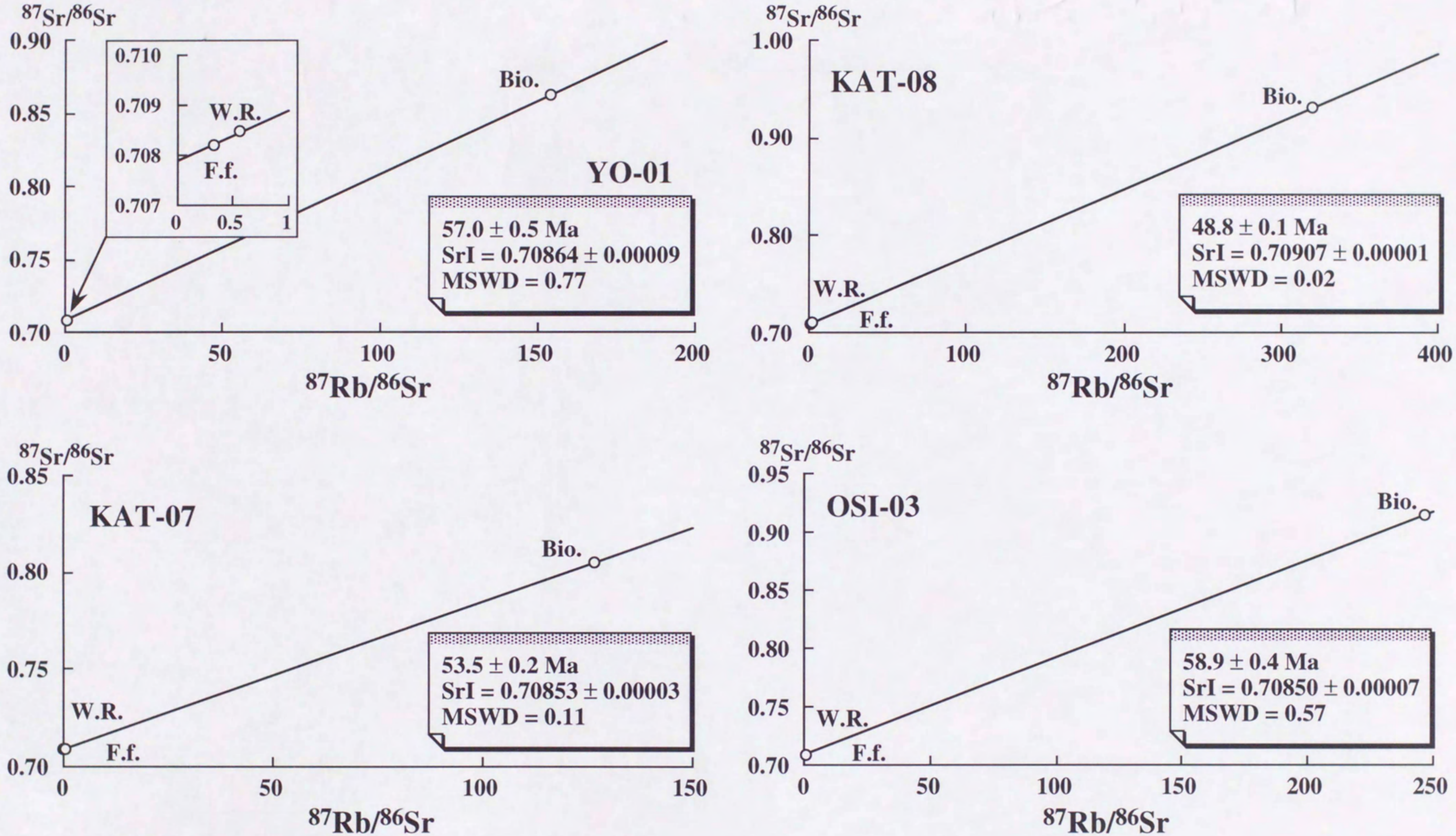


Fig.V-36 Rb-Sr whole-rock and mineral isochrons for the Ichida granite.
Bio:biotite, F.f.:felsic fraction, W.R.:whole-rock.

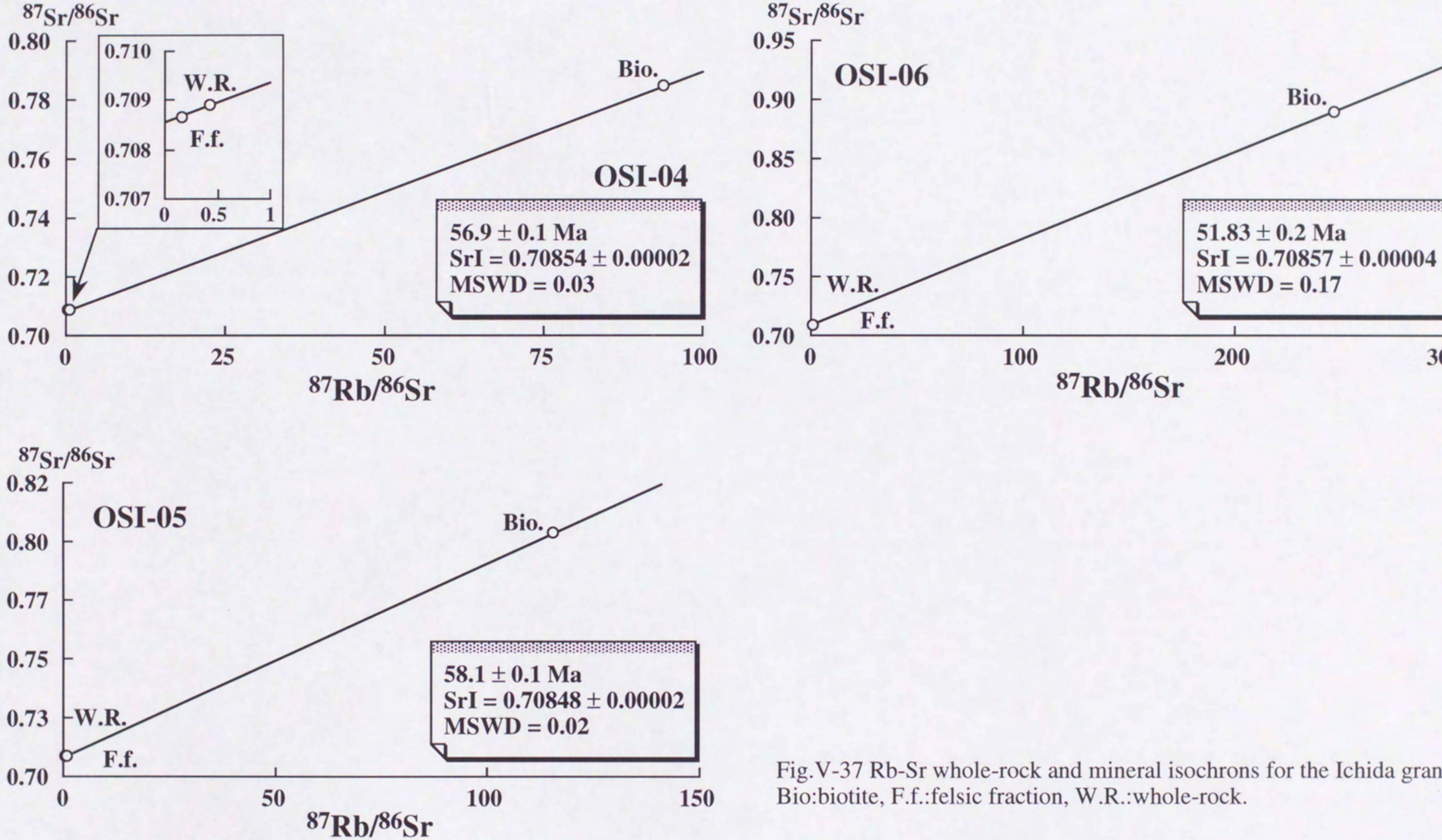


Fig.V-37 Rb-Sr whole-rock and mineral isochrons for the Ichida granite.
Bio:biotite, F.f.:felsic fraction, W.R.:whole-rock.

Table V-19 Trace element concentrations and isotopic data of the Takato granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
MI-17								
Biotite	219	3.21	200.7	0.87774(2)				
Hornblende	3.61	41.9	0.2492	0.70918(3)	32.8	117	0.1702	0.512281(10)
Felsic f.	6.61	735	0.02604	0.70868(1)	0.191	1.38	0.08329	0.512223(19)
MI-22								
Biotite	196	15.4	37.01	0.73997(1)				
Felsic f.	6.21	758	0.02368	0.70877(1)				
TAN-05								
Biotite	250	4.15	176.8	0.85372(2)				
Felsic f.	5.27	626	0.02435	0.70878(1)				
TAN-27								
Biotite	209	11.6	52.14	0.74840(1)				
Felsic f.	5.71	738	0.02237	0.70872(1)				
INO-04								
Biotite	228	4.69	142.8	0.87903(2)				
Felsic f.	6.10	670	0.02637	0.70878(1)				

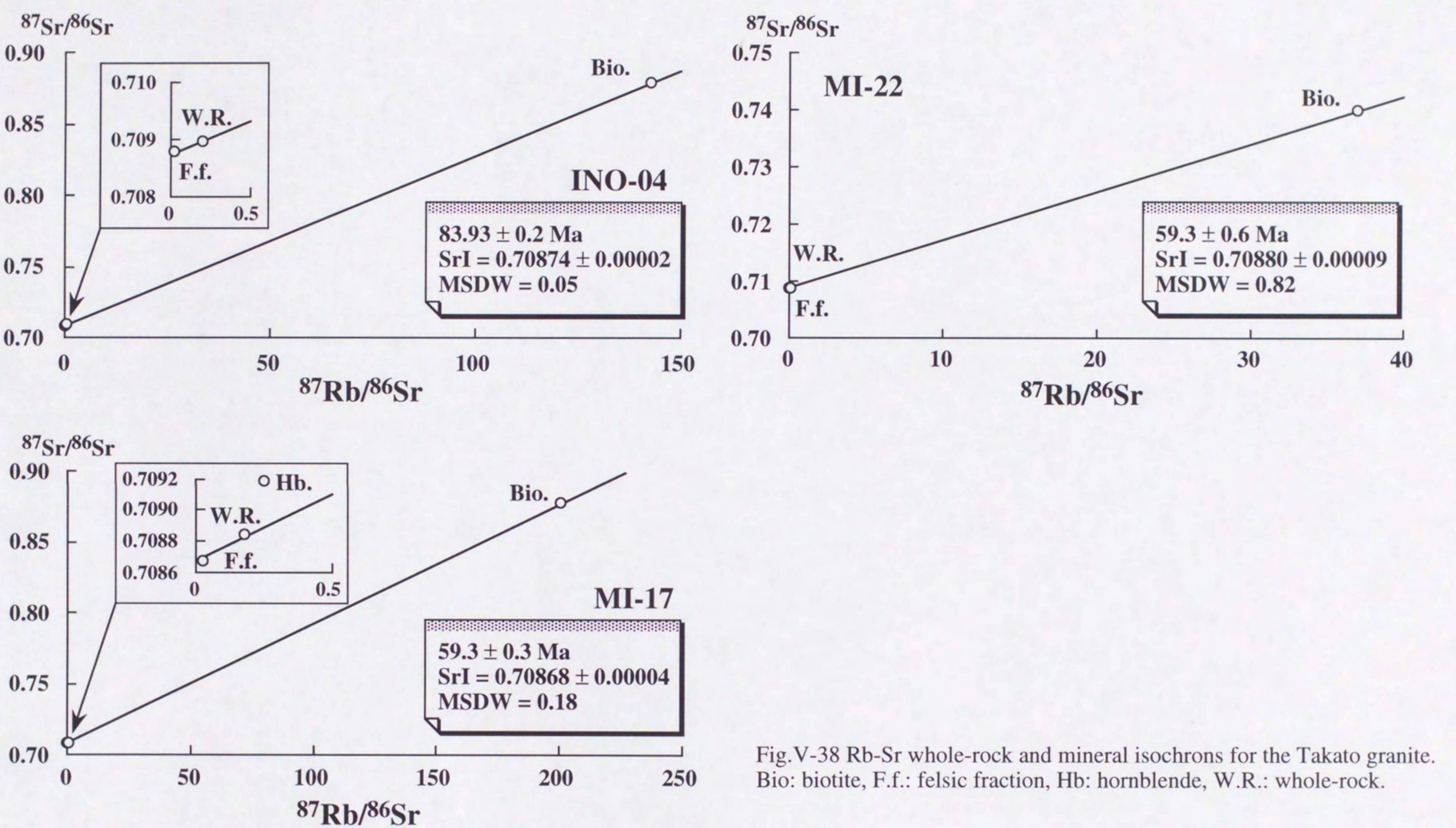
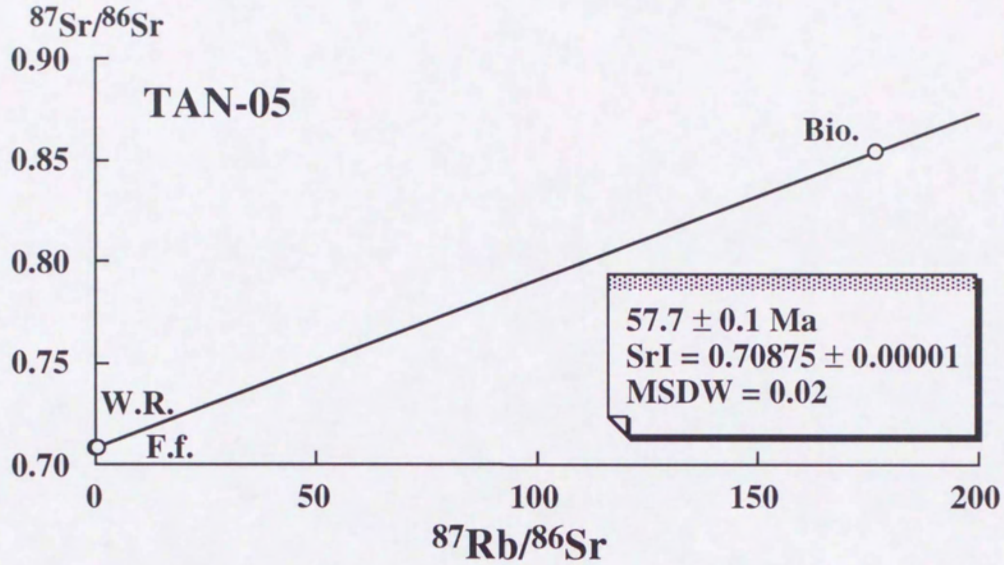


Fig.V-38 Rb-Sr whole-rock and mineral isochrons for the Takato granite.
Bio: biotite, F.f.: felsic fraction, Hb: hornblende, W.R.: whole-rock.



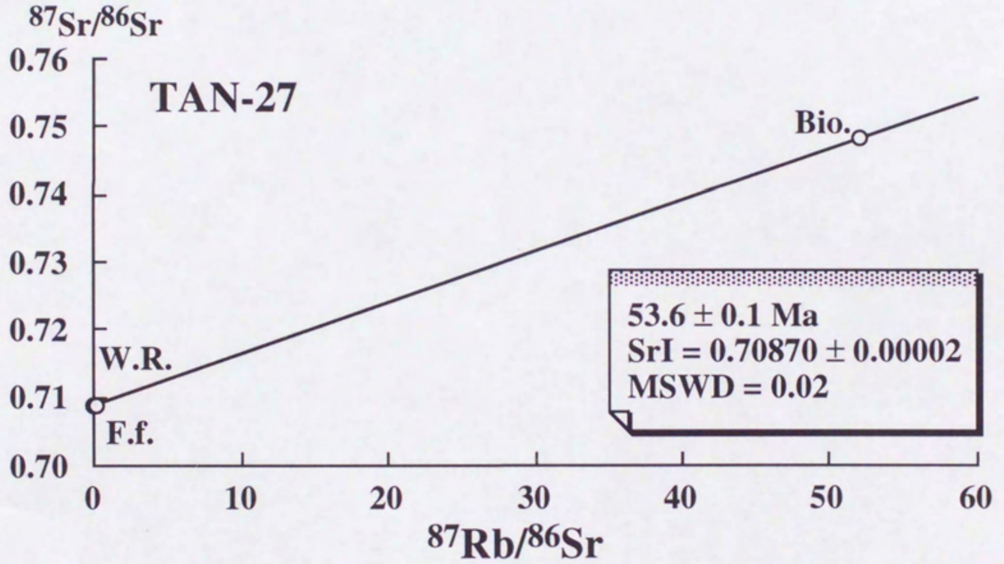


Fig.V-39 Rb-Sr whole-rock and mineral isochrons for the Takato granite.
Bio: biotite, F.f.: felsic fraction, W.R.: whole-rock.

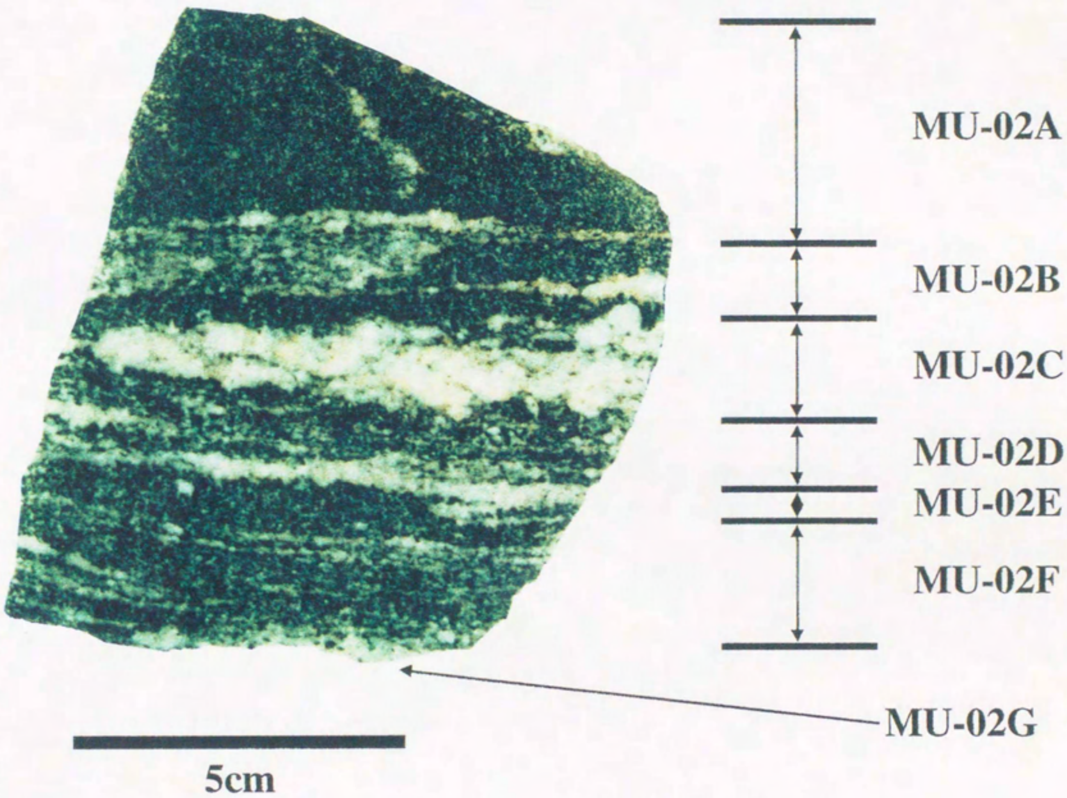


Fig.V-40 Photograph of the sample MU-02 from the Hiji quartzdiorite.

Table V-20 Trace element concentrations and isotopic data of the Hiji quartzdiorite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
MU-02	71.2	217	0.9493	0.70861(1)	3.74	13.5	0.1674	0.512372(10)
MU-02A	73.8	242	0.8829	0.70862(1)	4.36	15.9	0.1658	0.512409(9)
MU-02B	73.3	212	0.9992	0.70865(1)	3.34	12.1	0.1665	0.512387(11)
MU-02C	15.0	221	0.1972	0.70784(1)	0.600	2.94	0.1236	0.512346(11)
MU-02D	87.7	209	1.214	0.70882(1)	4.92	17.4	0.1705	0.512403(12)
MU-02E	38.7	224	0.5003	0.70817(1)	1.39	6.61	0.1275	0.512328(12)
MU-02F	64.9	207	0.9059	0.70858(1)	3.58	12.6	0.1724	0.512380(11)
MU-02G	36.2	194	0.5399	0.70830(1)	1.78	4.55	0.2358	0.512394(10)
ON-33	39.4	366	0.3116	0.70806(1)	12.3	46.6	0.1599	0.512386(11)
Biotite	376	5.17	214.0	0.88740(2)	0.431	1.14	0.2289	0.512272(80)
Hornblende	7.23	40.2	0.5211	0.70824(1)	28.8	78.2	0.2226	0.512360(10)
Felsic f.	22.8	420	0.1572	0.70791(1)	0.196	0.728	0.1630	0.512318(19)
ON-33A	27.5	378	0.2106	0.70798(1)	12.2	41.1	0.1788	0.512360(11)
ON-33B	66.7	362	0.5335	0.70828(1)	12.1	43.1	0.1697	0.512361(12)
ON-33C	61.4	365	0.4870	0.70820(1)	9.07	32.5	0.1686	0.512379(9)
ON-33D	44.1	375	0.3404	0.70807(1)	10.4	35.9	0.1748	0.512359(11)

The eight samples(MU-02 and MU-02A-G) form an isochron that indicates an age of 67.5± 8.2Ma with a SrI of 0.70771±0.00010(2σ)(Fig.V-41). In the Sm-Nd system, the isochron age is not given because of small variation on $^{147}Sm/^{144}Nd$.

ON-33 and four samples(ON-33A-D) form an isochron that indicates an age of 63.3±10.0Ma with a SrI of 0.70778±0.00006(2σ)(Fig.V-42). Further, mineral samples (biotite, hornblende and felsic fraction) and a whole-rock sample separated from ON-33 define an isochron age of 59.1±0.1(Fig.V-43). The agreement of both ages within range of error suggests that the composition of separated layers depend on amount of minerals(in particular, biotite, hornblende and felsic fraction). Thus, the ages of 67.5Ma and 63.3Ma do not indicate timing of formation of compositional layerings, but cooling age.

Kisokoma granodiorite

Biotite, hornblende and felsic fraction were separated from the nine samples, respectively.

The Rb-Sr and Sm-Nd data are given in Table V-21.

Mineral samples(biotite and felsic fraction) and a whole-rock sample define Rb-Sr whole-rock and mineral isochron ages of 54.1±0.3Ma(SHO-02), 60.0±0.1Ma(SHO-06), 58.4±0.3Ma(SHO-08), 57.6±0.4Ma(OG-07), 58.7±0.02Ma(OT-94), 62.8±0.1Ma(OG-08), 58.5±0.2Ma(OTK-20), 60.88±0.1Ma(INA-05), 64.2±0.2Ma(INA-07), respectively(Figs.V-44-46). In the Sm-Nd system, the age can not be given, because the variations in $^{143}Nd/^{144}Nd$ and $^{147}Sm/^{144}Nd$ ratios are small.

Kise granite

The Kise granite is medium grained (hornblende) biotite granodiorite and granite that is exposed along the Tenryu River in the north of Kise(Murayama and Katada, 1957). The amount of hornblende is very little.

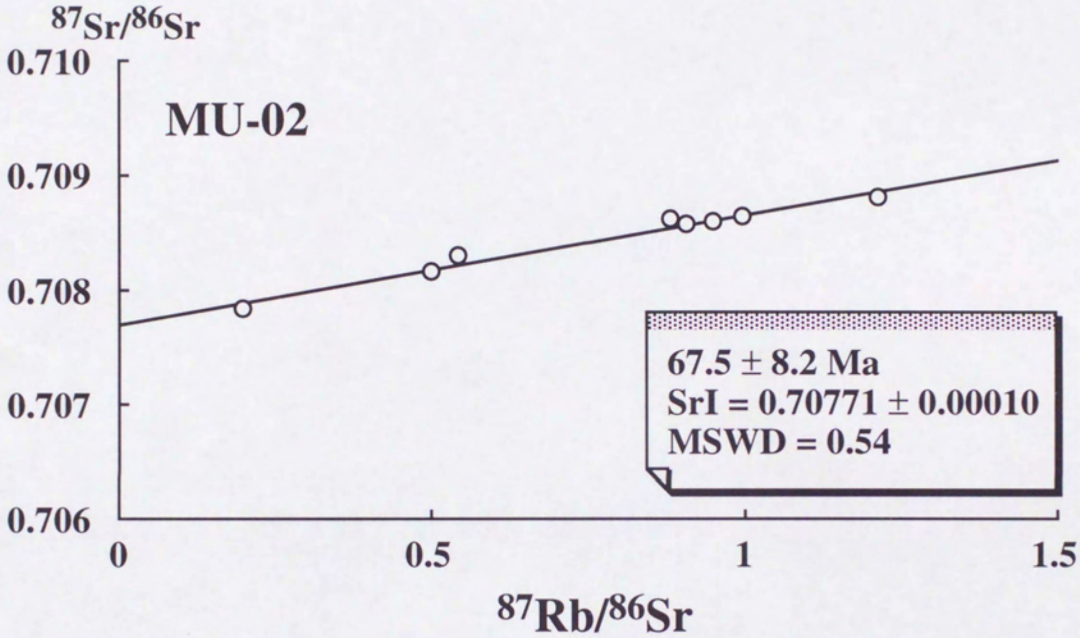


Fig.V-41 Rb-Sr isochron for the sample MU-02 from the Hiji quartzdiorite.

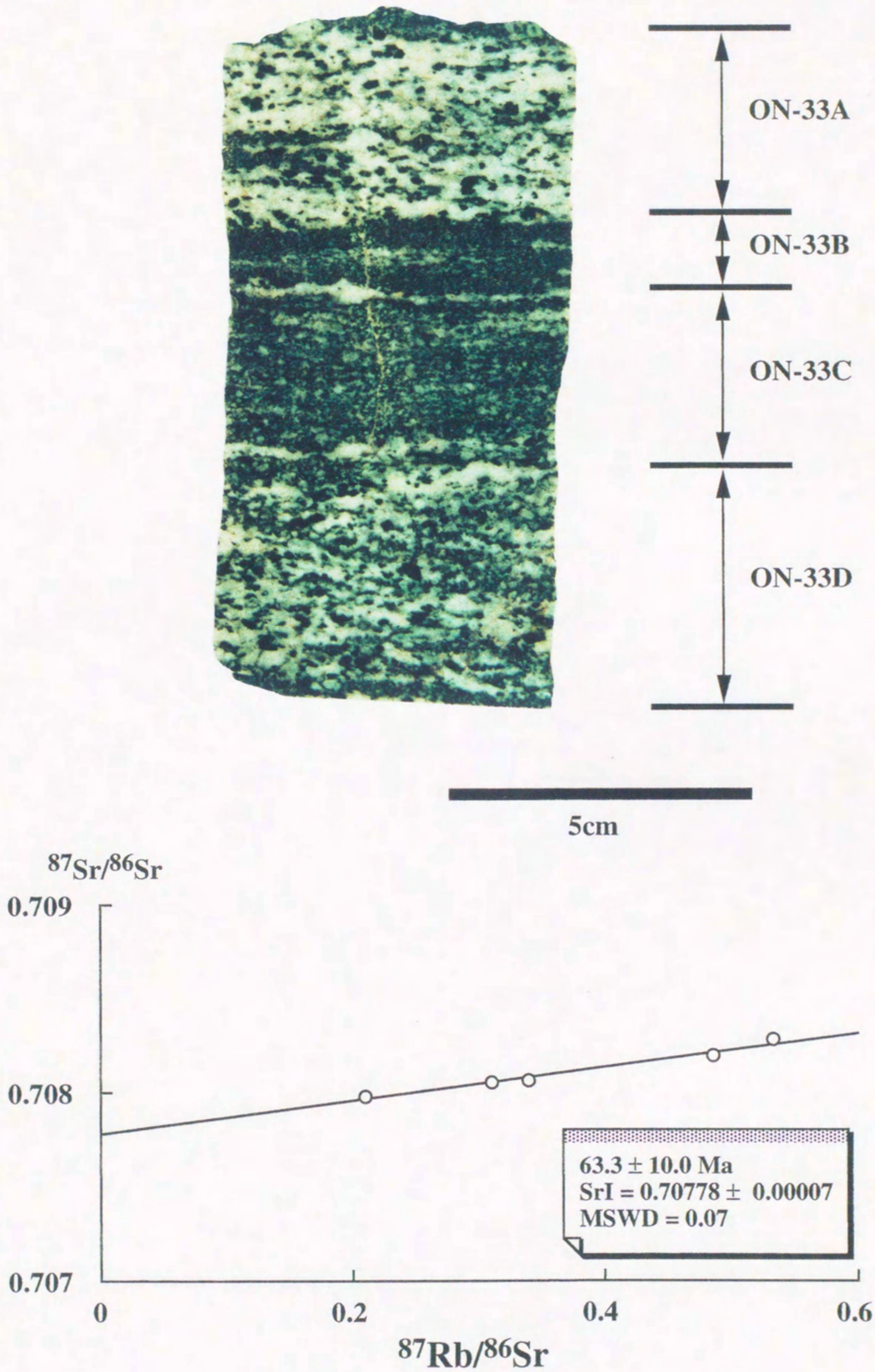


Fig.V-42 Rb-Sr isochron for the Hiji quartzdiorite.

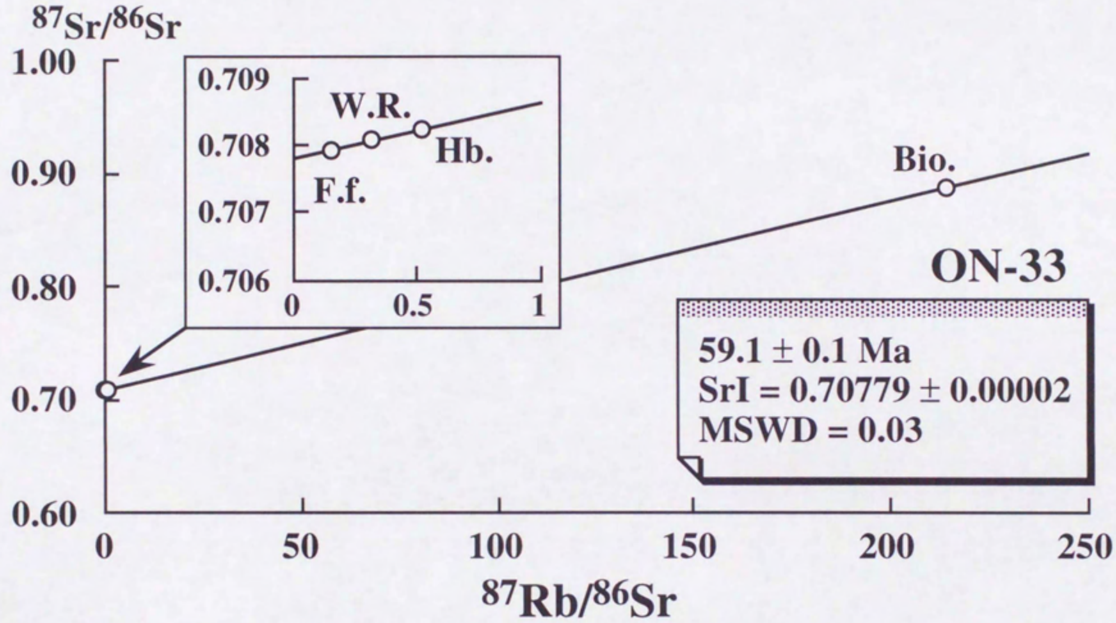


Fig.V-43 Rb-Sr whole-rock and mineral isochron for the Hiji quartzdiorite.
Bio: biotite, F.f.: felsic fraction, Hb: hornblende, W.R.: whole-rock.

Table V-21 Trace element concentrations and isotopic data of the Kisokoma granodiorite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
SHO-08								
Biotite	409	3.65	333.6	0.98600(1)	0.631	2.75	0.1389	0.512173(12)
Hornblende	4.15	24.1	0.4437	0.70929(1)	32.0	128	0.1514	0.512171(10)
Felsic f.	38.3	356	0.3116	0.70952(1)	0.445	3.01	0.08935	0.512161(11)
OT-94								
Biotite	332	2.86	345.8	0.99756(3)				
Hornblende	2.71	27.3	0.2870	0.70956(2)	30.8	112	0.1667	0.512188(9)
Felsic f.	23.2	421	0.1599	0.70943(1)	0.294	2.30	0.07708	0.512100(13)
SHO-06								
Biotite	421	2.46	516.8	1.14987(2)				
Hornblende	5.47	22.6	0.7014	0.70983(5)				
Felsic f.	23.9	390	0.1772	0.70936(1)				
OG-07								
Biotite	511	3.72	411.1	1.04605(4)	0.621	2.08	0.1804	0.512183(17)
Felsic f.	32.0	338	0.2742	0.70991(1)	0.502	3.06	0.09930	0.512148(14)
SHO-02								
Biotite	538	5.73	277.5	0.92293(2)	1.03	4.28	0.1460	0.512169(14)
Hornblende					48.6	151	0.1947	0.512172(10)
Felsic f.	43.6	318	0.3963	0.70993(1)	0.450	2.79	0.09753	0.512118(12)
OTK-20					5.000	21.30	0.1423	0.512174(11)
Biotite	429.0	4.29	296.3000	0.955780(2)				
Felsic f.	28.0	353	0.2296	0.70985(1)				
INA-05								
Biotite	426	7.00	178.7	0.86390(1)				
Felsic f.	20.7	409	0.1462	0.70948(1)				
INA-07								
Biotite	598	2.78	659.3	1.31123(2)				
Felsic f.	52.0	245	0.6138	0.71011(2)				

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
OGW-02								
Biotite	590	4.11	433	1.12468(2)				
Felsic f.	37.7	345	0.3166	0.70774(1)				
OG-08								
Biotite	446	2.73	494	1.15075(5)				
Felsic f.	20.3	393	0.1493	0.70996(1)				

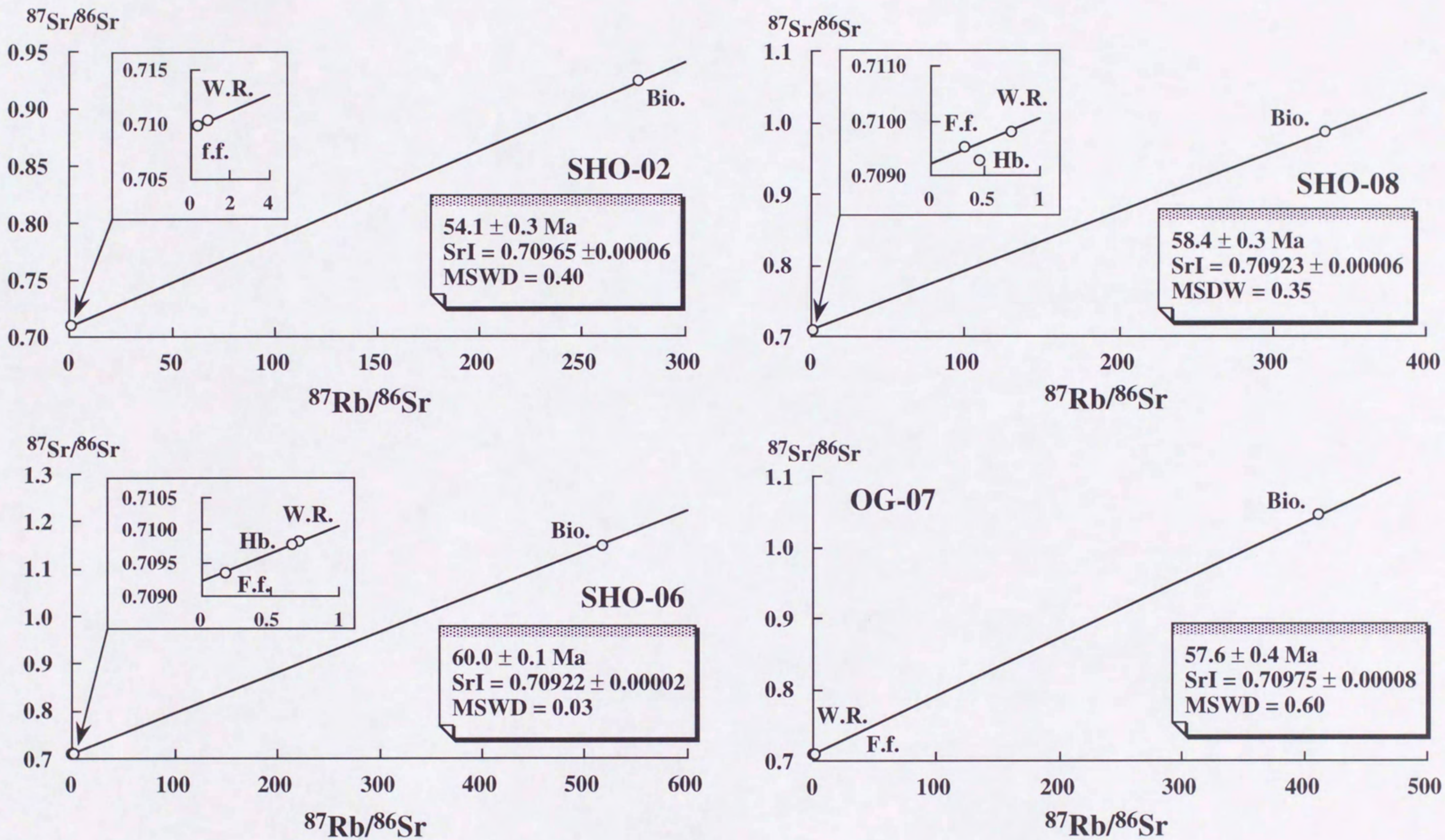


Fig.V-44 Rb-Sr whole-rock and mineral isochrons for the Kisokoma granodiorite.
Bio: biotite, F.f.: felsic fraction, Hb: hornblende, W.R.: whole-rock.

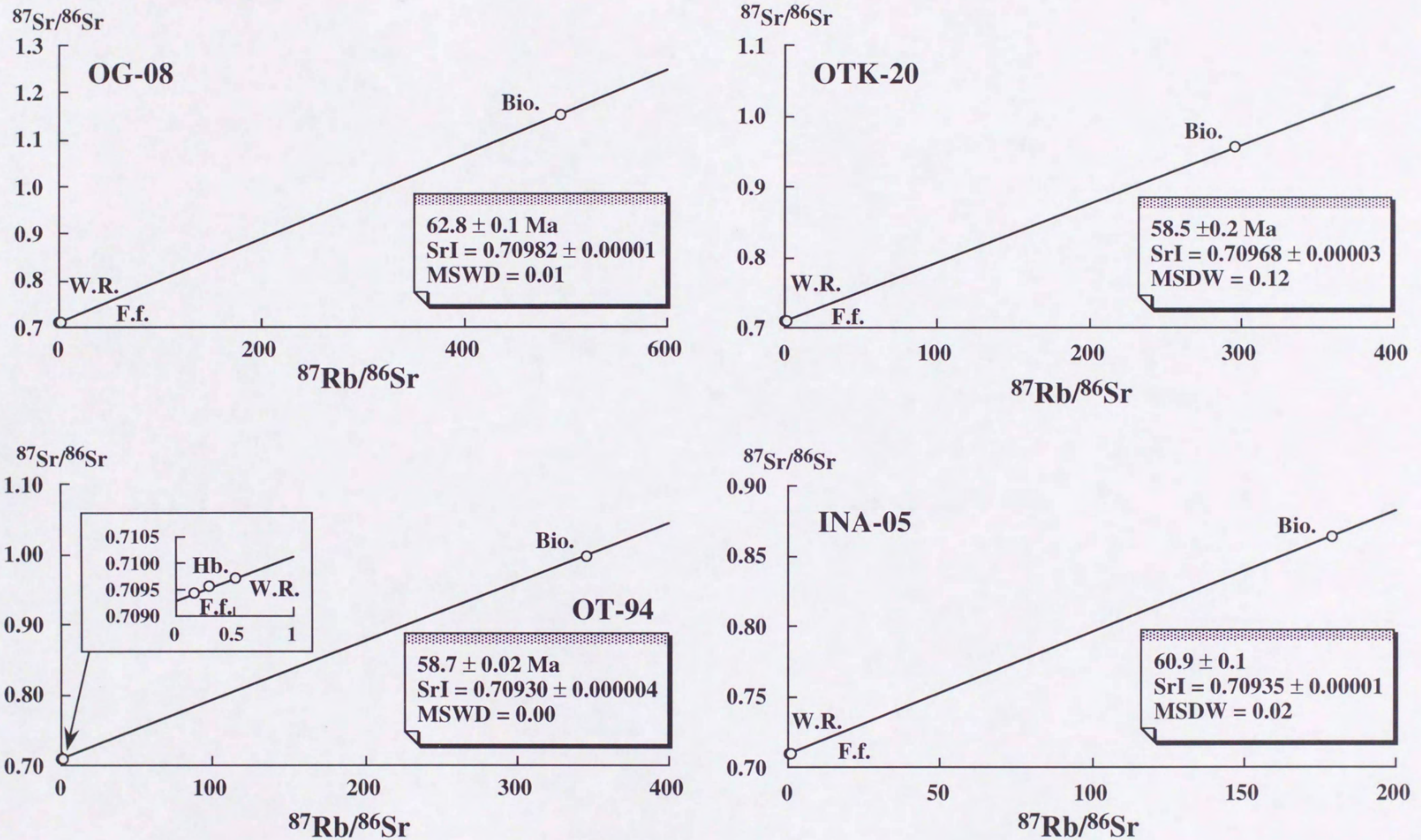


Fig.V-45 Rb-Sr whole-rock and mineral isochrons for the Kisokoma granodiorite.
Bio: biotite, F.f.: felsic fraction, Hb: hornblende, W.R.: whole-rock.

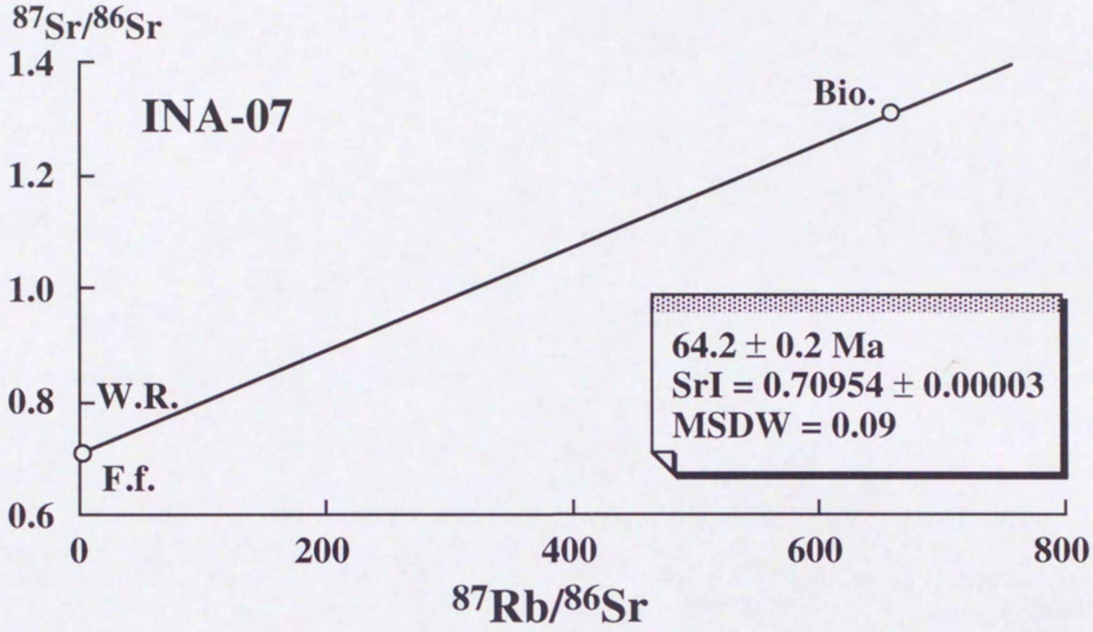


Fig.V-46 Rb-Sr whole-rock and mineral isochron for the Kisokoma granodiorite. Bio: biotite, F.f.: felsic fraction, W.R.: whole-rock.

The three whole-rock samples, TN-44, TN-45 and TN-51, were collected from the Kise granite(Fig.V-47). Biotite and felsic fraction were separated from these samples.

Whole rock chemical compositions of these samples are given in Table V-22. The Rb-Sr and Sm-Nd data are given in Table V-23.

Biotite, felsic fraction and a whole-rock sample define Rb-Sr whole-rock and mineral isochron ages of 59.0±0.4Ma(TN-44), 58.4±0.1Ma(TN-45) and 61.3±0.5Ma(TN-51)(Fig.V-48).

Hissori granite

The five samples, KI-03, KI-07, JI-22, JI-23 and AS-01, were collected from the Hissori granite(Fig.V-49). Biotite, hornblende and felsic fraction were separated from three samples.

Whole rock chemical compositions of these samples are given in Table V-24. The Rb-Sr and Sm-Nd data are given in Table V-25.

Biotite, felsic fraction and a whole-rock sample define Rb-Sr whole-rock and mineral isochron ages of 64.5±0.1Ma(JI-22), 61.0±0.1Ma(JI-33) and 65.2±0.3Ma(KI-03)(Fig.V-50).

Basic metamorphic rock

Biotite and felsic fraction were separated from basic gneiss(MIT-60 and 61). This basic gneiss is five to forty centimeters thick, and composed mainly biotite, orthopyroxene, plagioclase and quartz.

The Rb-Sr and Sm-Nd data of these fractions and whole-rock sample are given in Table V-26. These samples were collect from the Mibu River nearby the Takato.

Mineral samples and a whole-rock sample define a Rb-Sr whole-rock and mineral isochron age of 61.3±1.0Ma(MIT-60) and 57.8±1.1Ma(MIT-61)(Fig.V-51). These isochron have slightly large error and MSWD, but conform the Rb-Sr whole-rock and biotite isochron ages reported by Okano(1982) in this area.

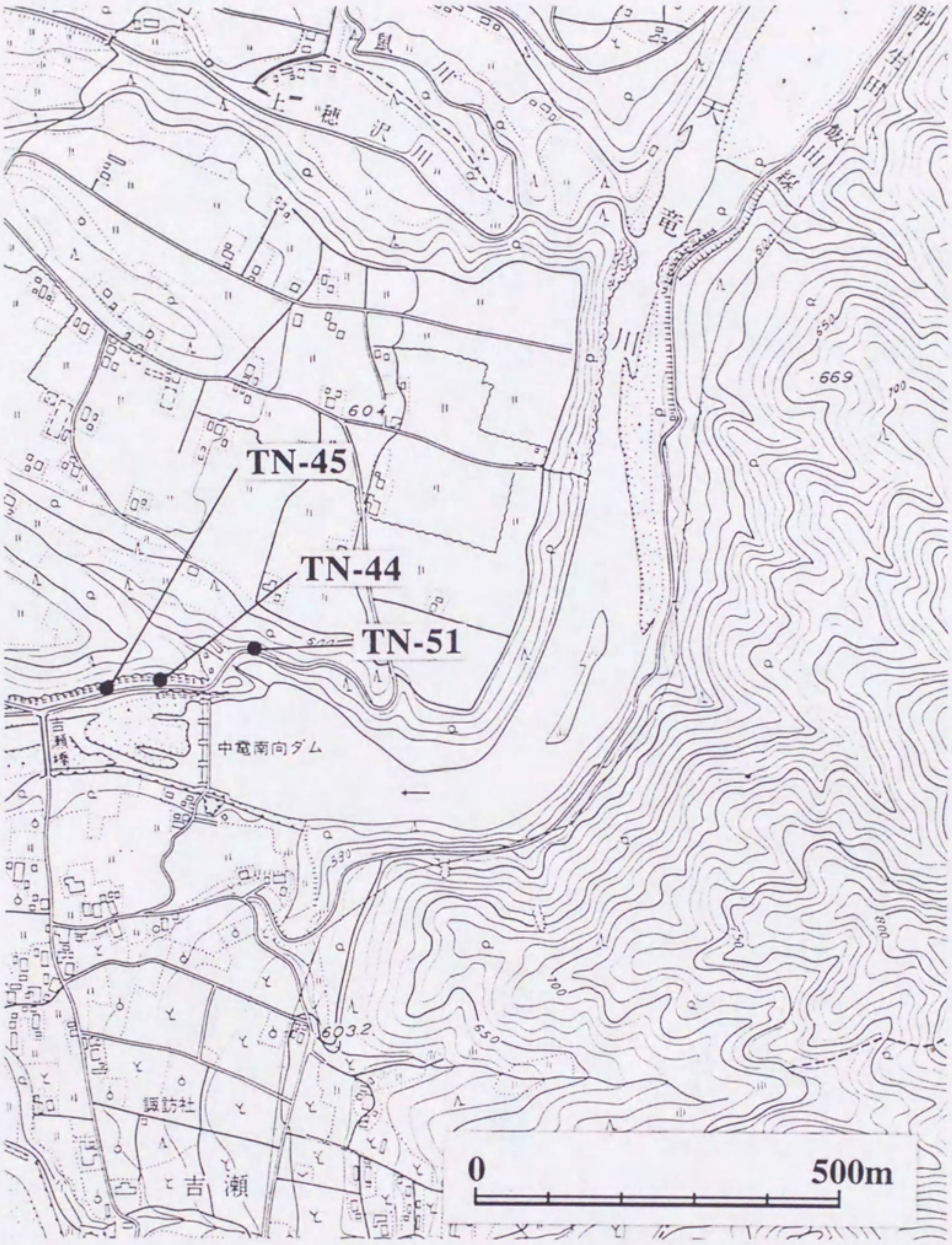


Fig.V-47 Sample localities of the Kise granite.
Topographic map is part of 1/10,000 map sheet "Komagane city (Ryuto 2)" of the Komagame city.

Table V-22 Whole-rock chemical compositions of the Kise granite.

Sample No.	TN-44	TN-45	TN-51
SiO_2	70.04	70.98	68.02
TiO_2	0.43	0.44	0.50
Al_2O_3	14.75	14.28	15.55
FeO*	3.03	2.99	3.26
MnO	0.06	0.06	0.08
MgO	0.91	0.88	1.13
CaO	3.04	3.22	3.37
Na_2O	3.13	3.17	4.01
K_2O	2.65	2.37	2.17
P_2O_5	0.11	0.11	0.13
Total	98.15	98.51	98.22
Ba	862	615	
Cu			
Nb	8	8	
Ni	4	4	
Rb	65.1	61.2	84.9
Sr	368	359	361
Y	17	18	
Zn	58	55	
Zr	165	163	

Table V-23 Trace element concentrations and isotopic data of the Kise granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
TN-44	65.1	368	0.5121	0.70901(1)	3.87	19.3	0.1214	0.512351(9)
Biotite	403	7.05	167.5	0.84882(2)	1.96	3.81	0.3101	0.512324(12)
Felsic f.	22.6	359	0.1820	0.70867(1)	0.330	1.37	0.1454	0.512314(16)
TN-45	61.2	359	0.4936	0.70898(1)	4.82	26.4	0.1102	0.512353(10)
Biotite	405	6.86	173.3	0.85272(2)				
Felsic f.	17.3	324	0.1543	0.70869(1)				
TN-51	84.9	361	0.6805	0.70901(1)	4.36	21.3	0.1241	0.512316(11)
Biotite	452	3.96	340.2	1.00474(4)				
Felsic f.	15.2	354	0.1241	0.70861(1)				

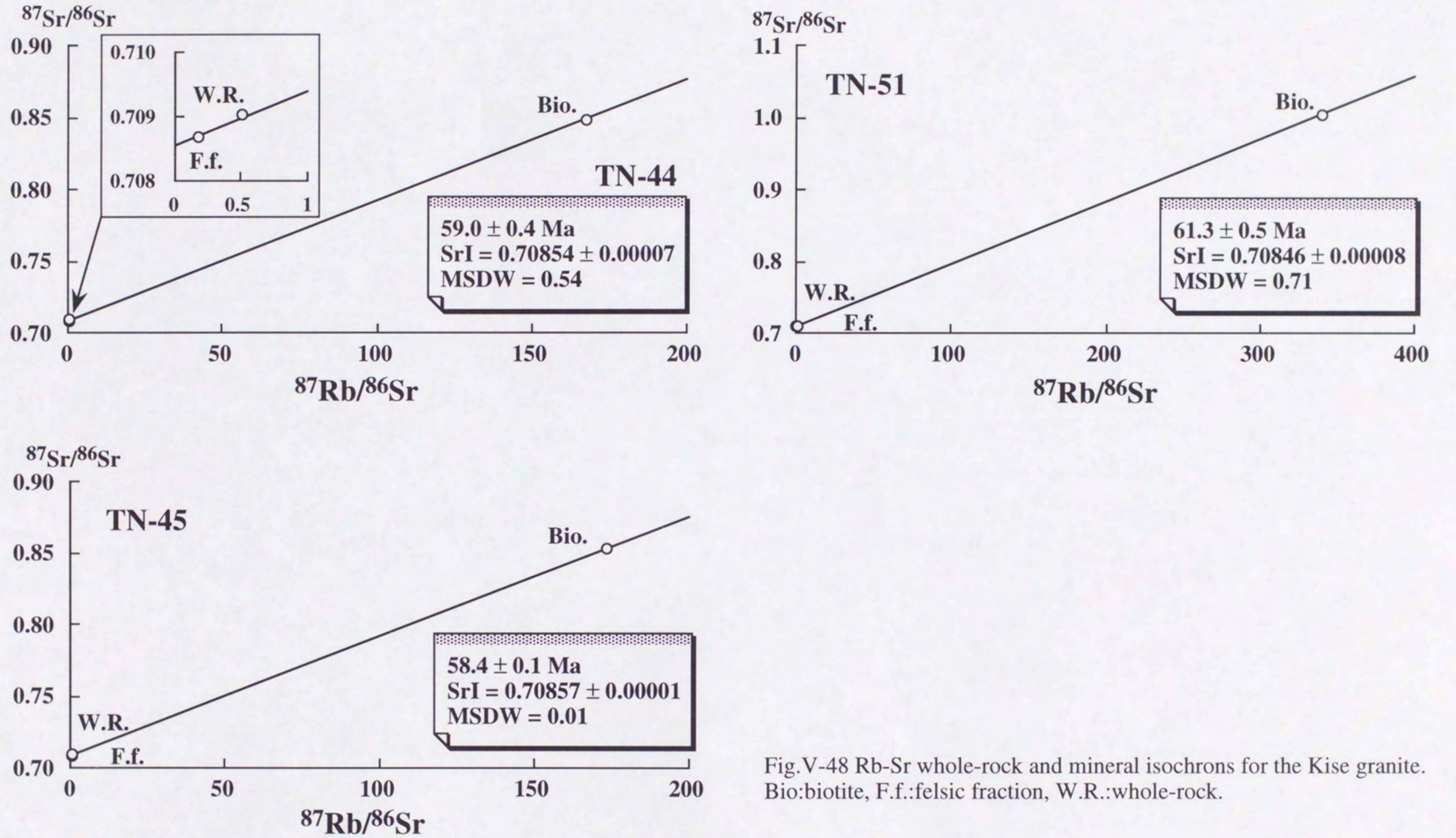


Fig.V-48 Rb-Sr whole-rock and mineral isochrons for the Kise granite. Bio:biotite, F.f.:felsic fraction, W.R.:whole-rock.

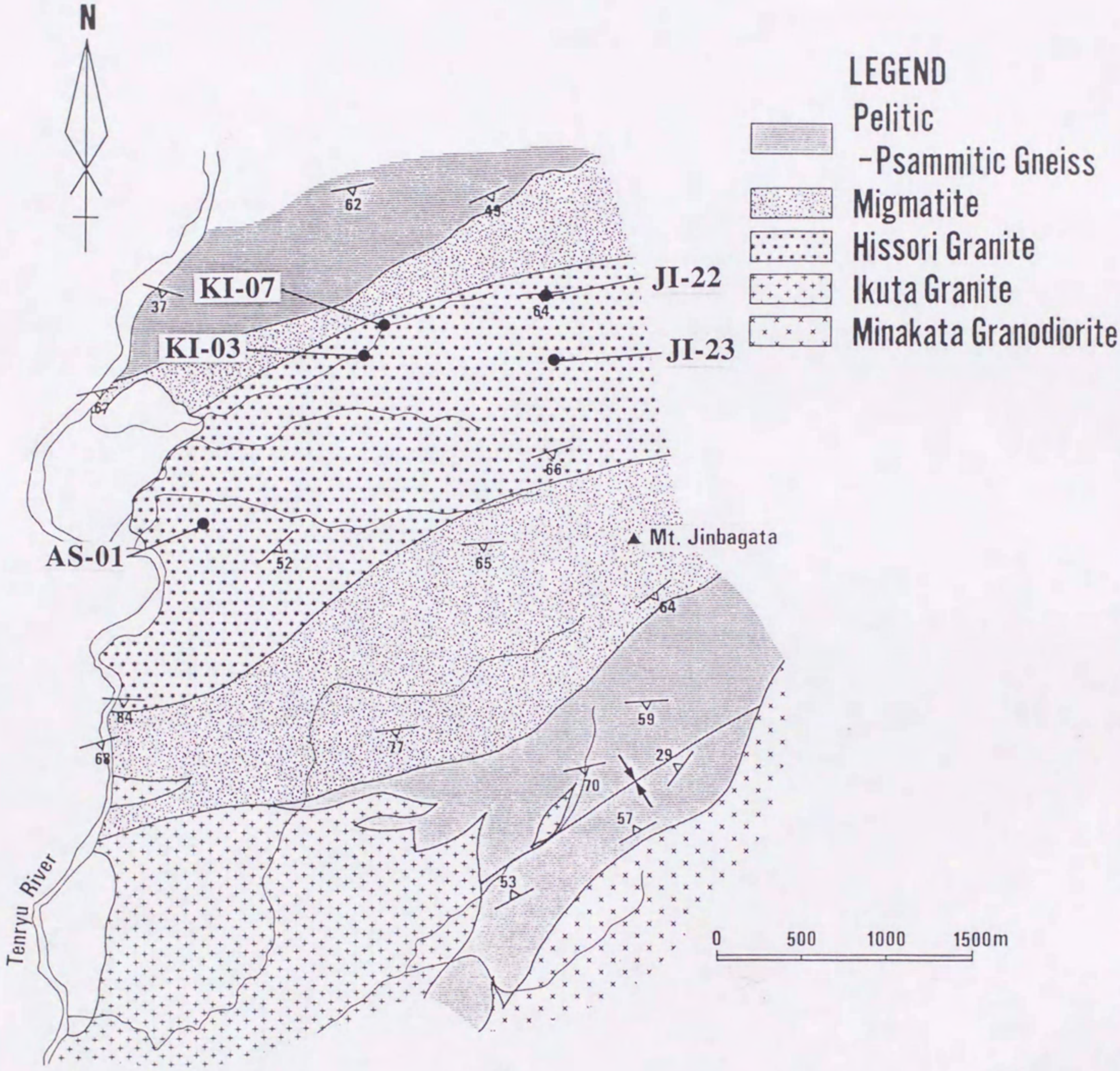


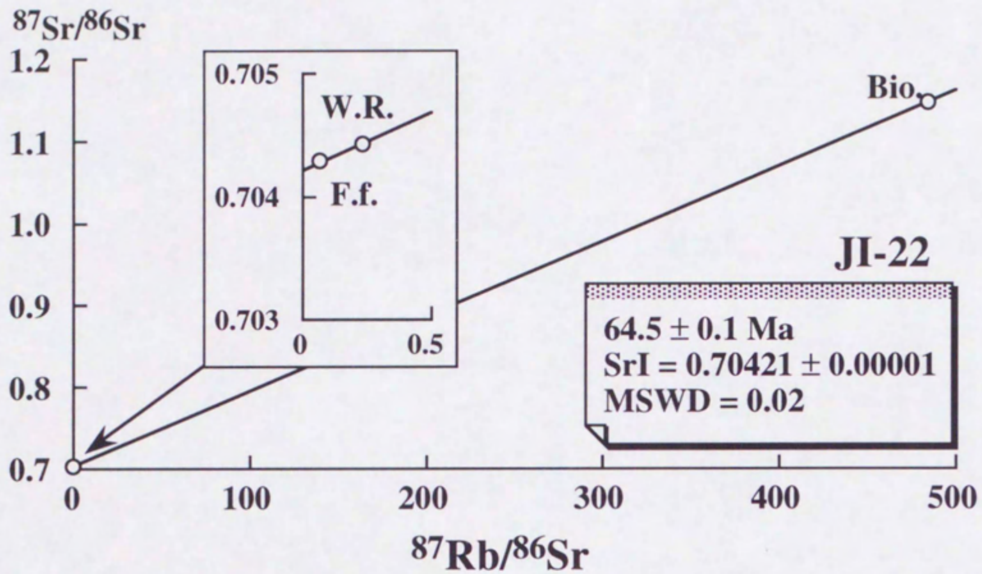
Fig.V-49 Sample localities of the Hissori granite.

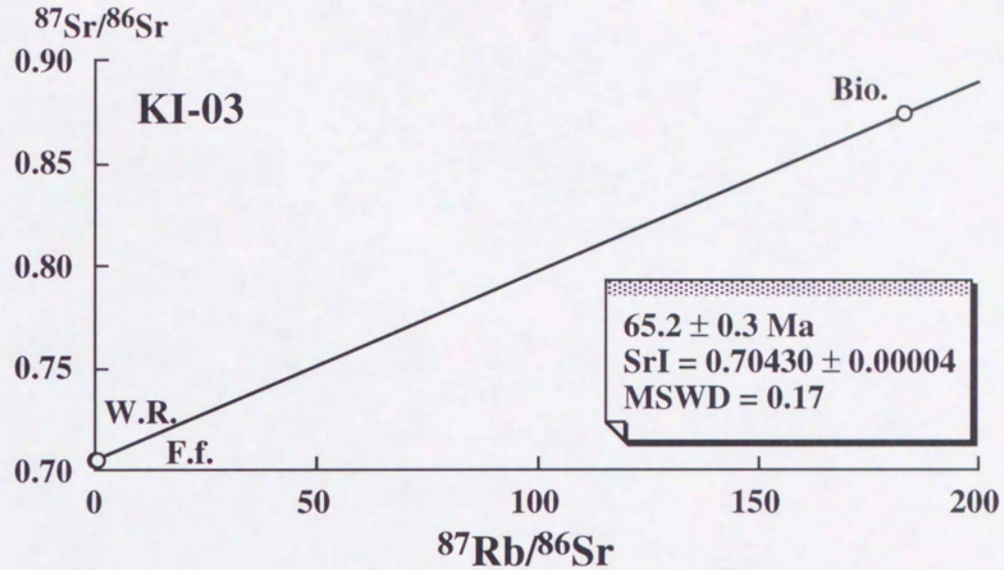
Table V-24 Whole-rock chemical compositions of the Hissori granite.

Sample No.	KI-07	KI-03	JI-22	JI-23
SiO_2	65.10	65.13	65.70	67.04
TiO_2	0.59	0.63	0.57	0.45
Al_2O_3	16.09	16.13	15.84	15.49
FeO*	3.22	3.57	3.12	2.50
MnO	0.07	0.08	0.07	0.05
MgO	1.79	1.97	1.80	1.35
CaO	3.92	3.78	3.35	2.90
Na_2O	5.03	4.86	4.87	4.69
K_2O	2.01	2.45	2.45	2.65
P_2O_5	0.23	0.24	0.21	0.16
Total	98.05	98.84	97.96	97.28

Table V-25 Trace element concentrations and isotopic data of the Hissori granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
KI-03	74.6	1148	0.1881	0.70449(1)	4.78	30.1	0.09599	0.512574(11)
Biotite	592	9.50	183.3	0.87409(2)				
Felsic f.	27.5	1343	0.05923	0.70433(1)				
JI-22	85.8	1054	0.2356	0.70442(1)	4.62	28.3	0.09856	0.512565(11)
Biotite	680	4.24	484.0	1.14775(2)				
Felsic f.	28.1	1215	0.06690	0.70428(1)				
JI-23	73.2	1061	0.1995	0.70440(1)	3.68	22.0	0.1014	0.512586(13)
Biotite	637	5.78	327.3	0.98773(1)				
Felsic f.	32.6	1155	0.08174	0.70431(1)				
AS-01	72.1	1102	0.1892	0.70454(1)	3.03	18.2	0.1006	0.512586(10)





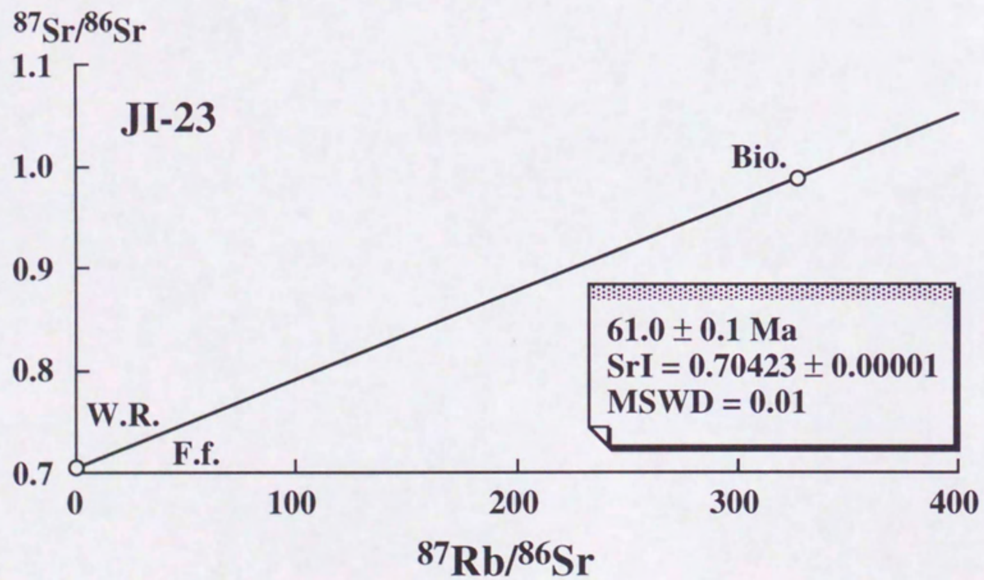
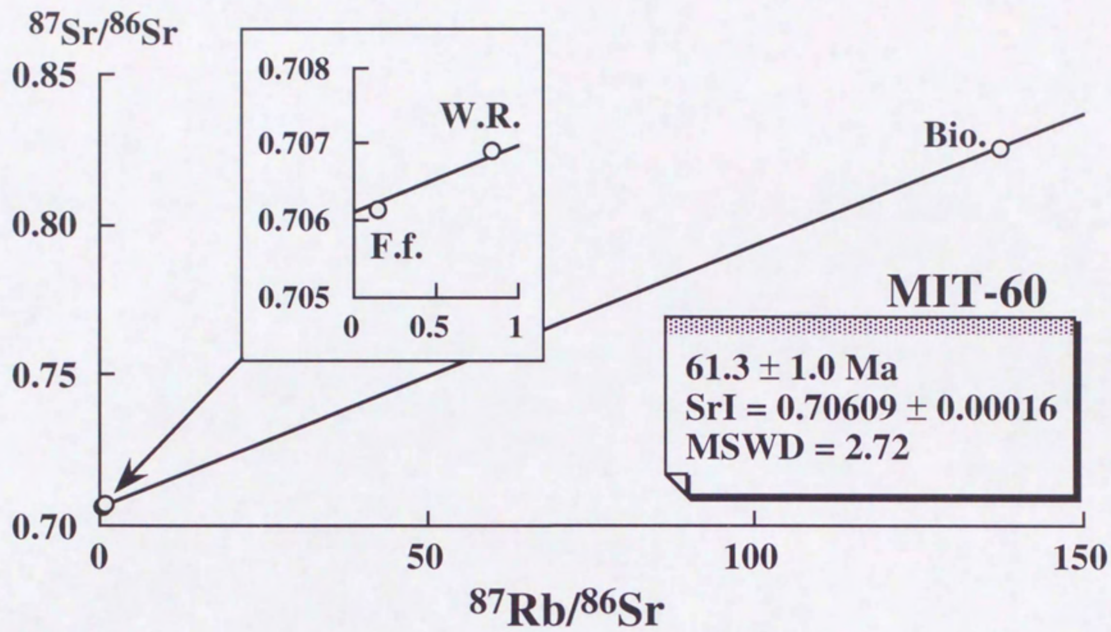


Fig.V-50 Rb-Sr whole-rock and mineral isochrons for the Hissori granite.
Bio:biotite, F.f.:felsic fraction, W.R.:whole-rock.

Table V-26 Trace element concentrations and isotopic data of the basic metamorphic rocks.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
MIT-60	108	370	0.8422	0.70691(1)	4.91	22.6	0.1315	0.512697(11)
Biotite	426	9.09	137.3	0.82569(1)	0.472	1.95	0.1459	0.512679(14)
Felsic fraction	32.0	627	0.1477	0.70614(1)	1.54	7.35	0.1267	0.512670(14)
MIT-61	127	328	1.121	0.71028(1)	5.08	23.4	0.1310	0.512287(12)
Biotite	459	8.71	154.3	0.83591(1)	0.804	3.98	0.1221	0.512286(14)
Felsic fraction	9.65	760	0.03673	0.70920(1)	1.19	7.78	0.0924	0.512277(14)



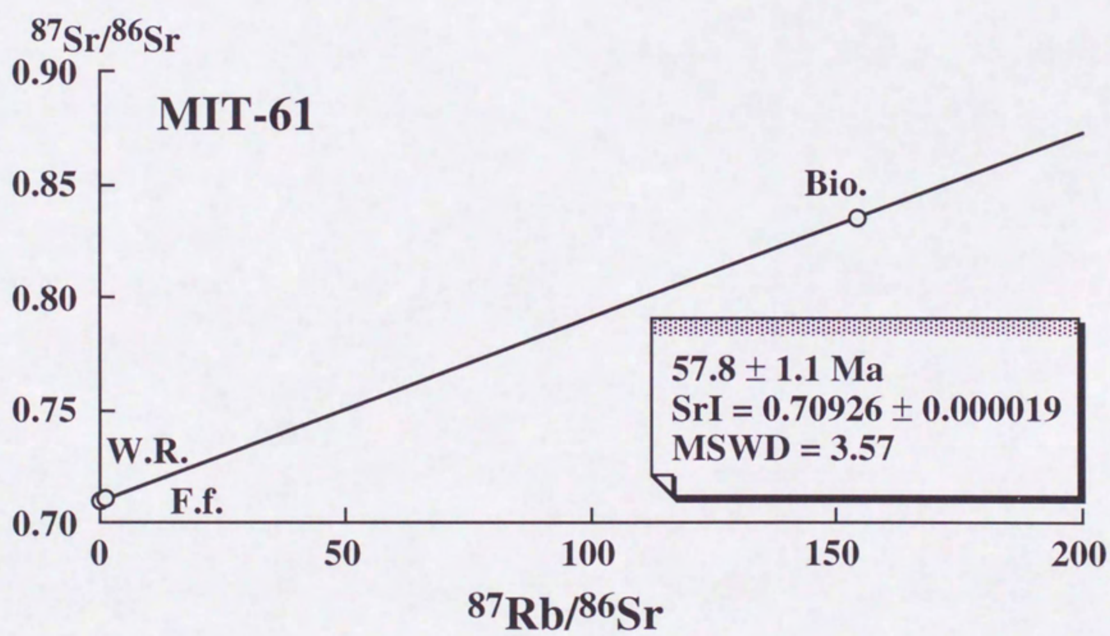


Fig.V-51 Rb-Sr whole-rock and mineral isochrons for the basic metamorphic rocks.
Bio:biotite, F.f.:felsic fraction, W.R.:whole-rock.

Ikuta granite

One sample(KSB-01) was collected from the Ikuta granite. The sample locality is shown in Figure V-52. Biotite, hornblende and felsic fraction were separated from KSB-01.

The Rb-Sr and Sm-Nd data of these fractions and whole-rock sample are given in Table V-27.

Mineral samples and a whole-rock sample give a Rb-Sr whole-rock and mineral isochron age of 60.5±0.2Ma(Fig.V-53).

Kiyosaki granite

The Kiyosaki granite mainly consists of medium grained hornblende biotite granodiorite and quartz diorite(Koide, 1949). This granite is exposed in the area nearby Kiyosaki, Shidara Town, Aichi Prefecture. K-Ar biotite ages of 70-100Ma(Banno and Miller, 1965; Ozima et al., 1967) and U-Pb zircon age of approximately 100Ma(Banks and Shimizu, 1969) have been reported about this body.

One sample(KNS-01) was collected from this body. The sample locality is shown in Figure V-54. Biotite, hornblende and felsic fraction were separated from KNS-01.

The Rb-Sr and Sm-Nd data of these fractions and whole-rock sample are given in Table V-28.

Mineral samples and a whole-rock sample give Rb-Sr whole-rock and mineral isochron ages of 63.5±0.3Ma(Fig.V-55).

Gabbro

Hornblende and felsic fraction were separated from two samples, OHA-04 and OHA-05, collected from the Ohata mass. These samples are medium grained hornblende gabbro that is composed of plagioclase, hornblende, cummingtonite and biotite with small amount of quartz.

The Rb-Sr and Sm-Nd data of these fractions and whole-rock sample are given in Table V-14.

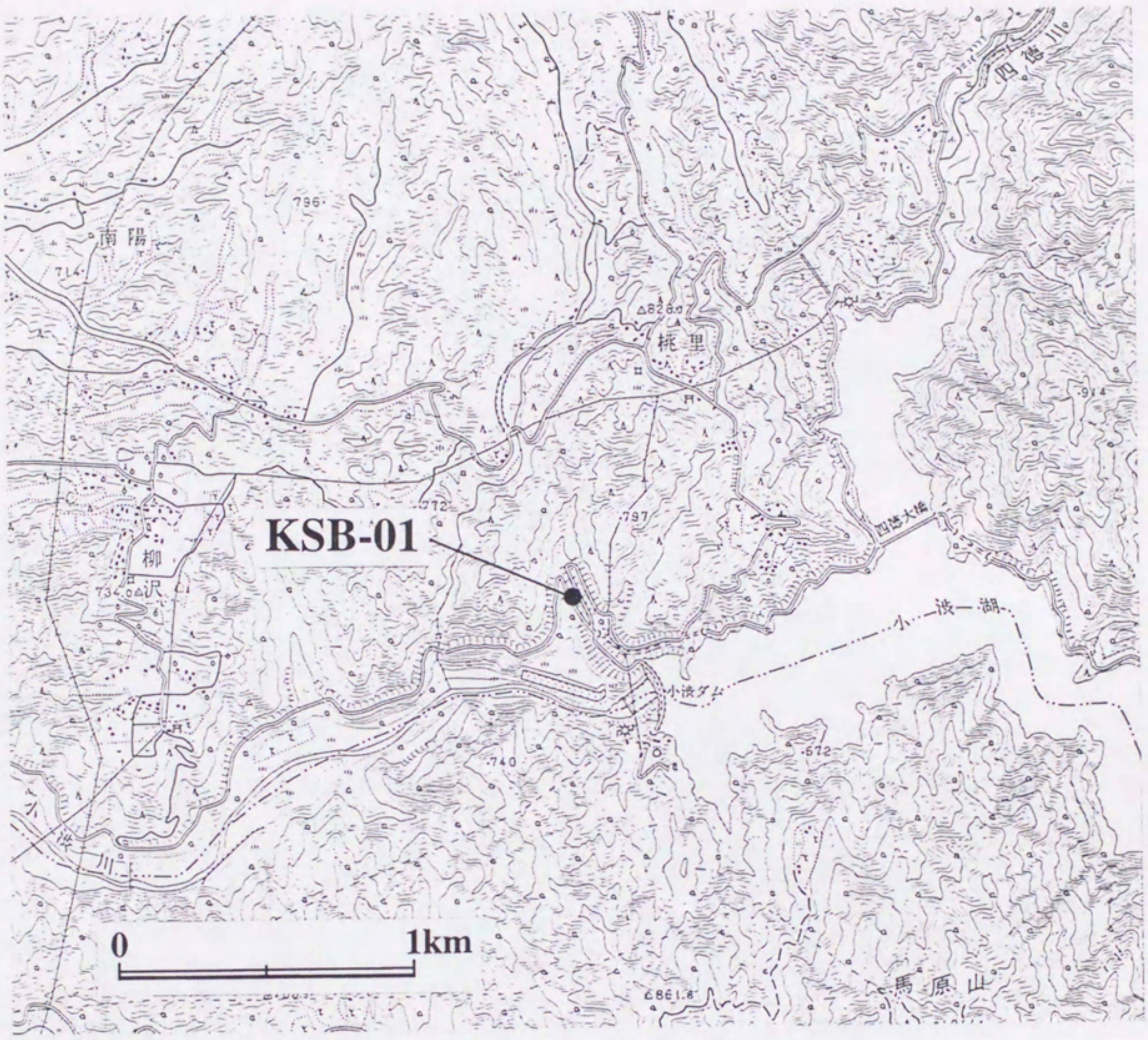


Fig.V-52 Sample locality of the Ikuta granite.
Topographic map is part of 1/25,000 map sheet "Inaojima" of Geographical Survey Institute of Japan.

Table V-27 Trace element concentrations and isotopic data of the Ikuta granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
KSB-01	100	310	0.9360	0.70831(1)	4.30	22.3	0.1166	0.512305(10)
Biotite	690	3.61	580.2	1.20598(2)				
Felsic f.	36.80	345	0.30890	0.70774(1)				

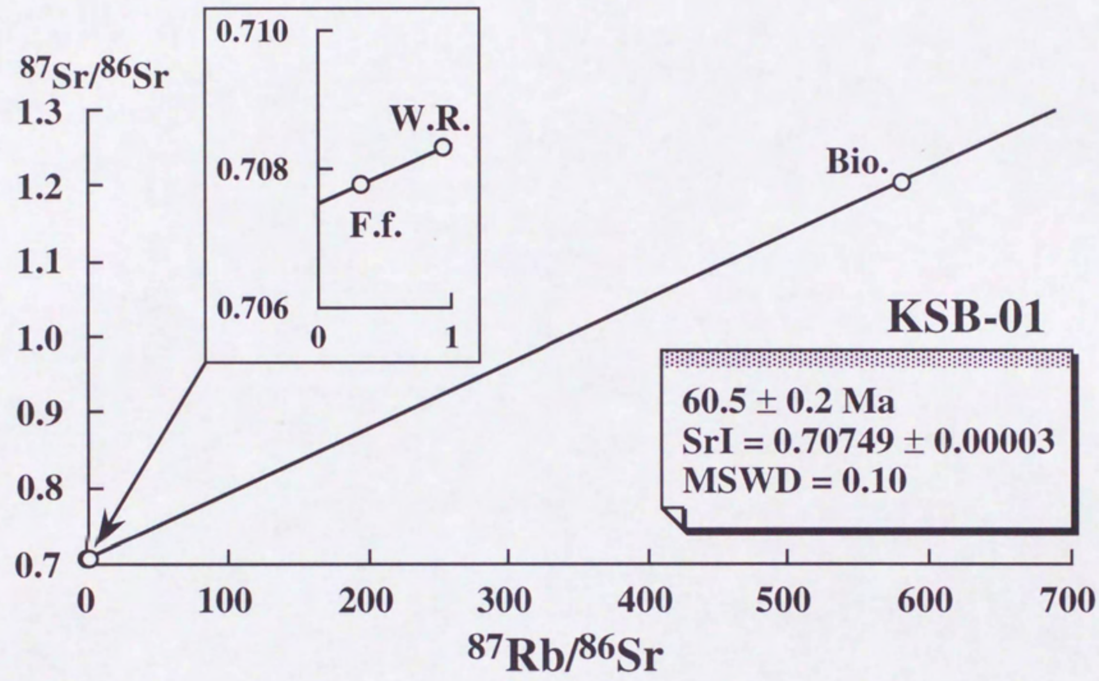


Fig.V-53 Rb-Sr whole-rock and mineral isochron for the Ikuta granite.
Bio:biotite, F.f.:felsic fraction, W.R.:whole-rock.

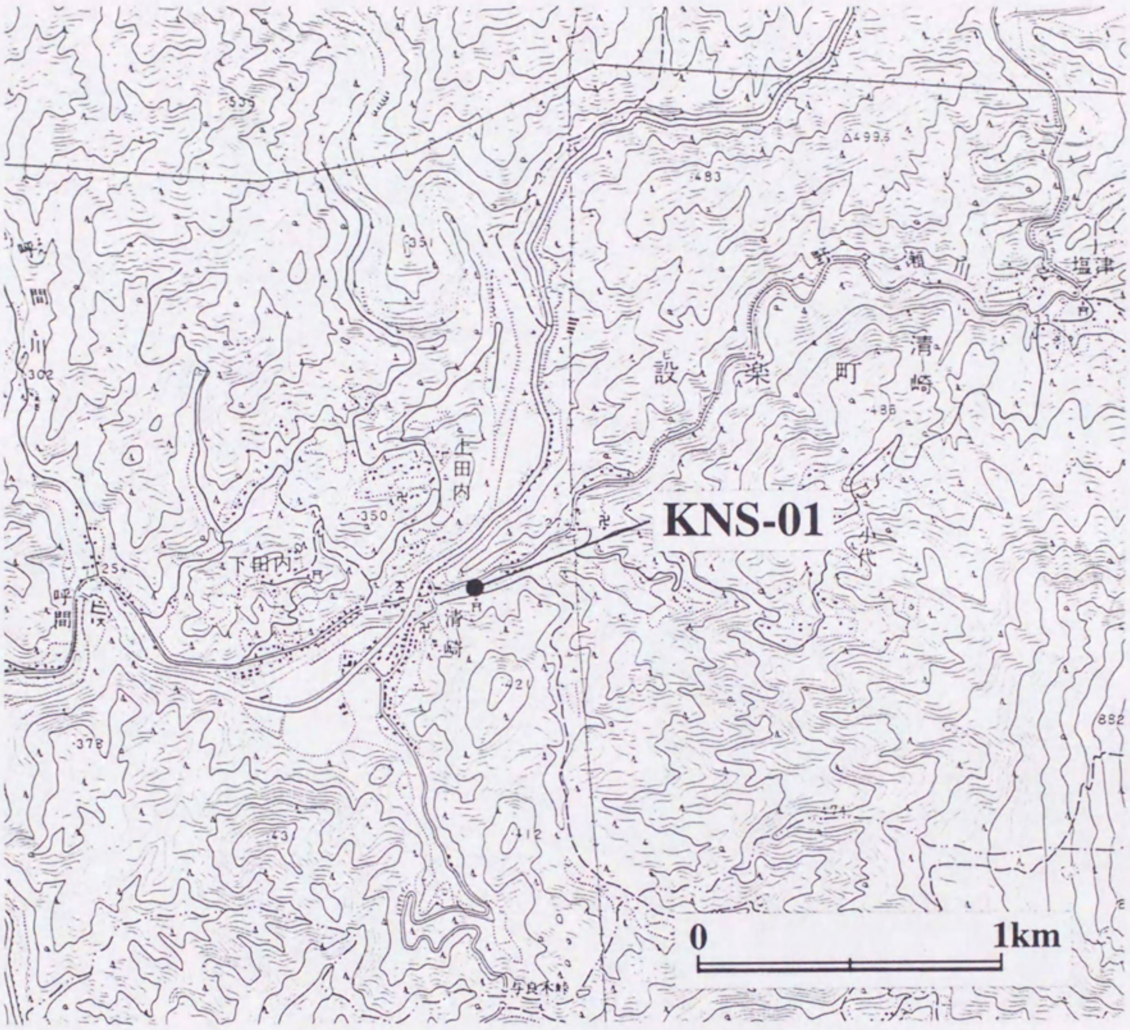


Fig.V-54 Sample locality of the Kiyosaki granite.
Topographic map is part of 1/25,000 map sheet "Ebi" of Geographical Survey Institute of Japan.

Table V-28 Trace element concentrations and isotopic data of the Kiyosaki granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)
KNS-01	83.8	305	0.7964	0.70799(1)	6.21	27.7	0.1353	0.512379(10)
Biotite	417	1.39	942.6	1.55710(4)				
Felsic f.	8.35	407	0.05939	0.70738(1)				

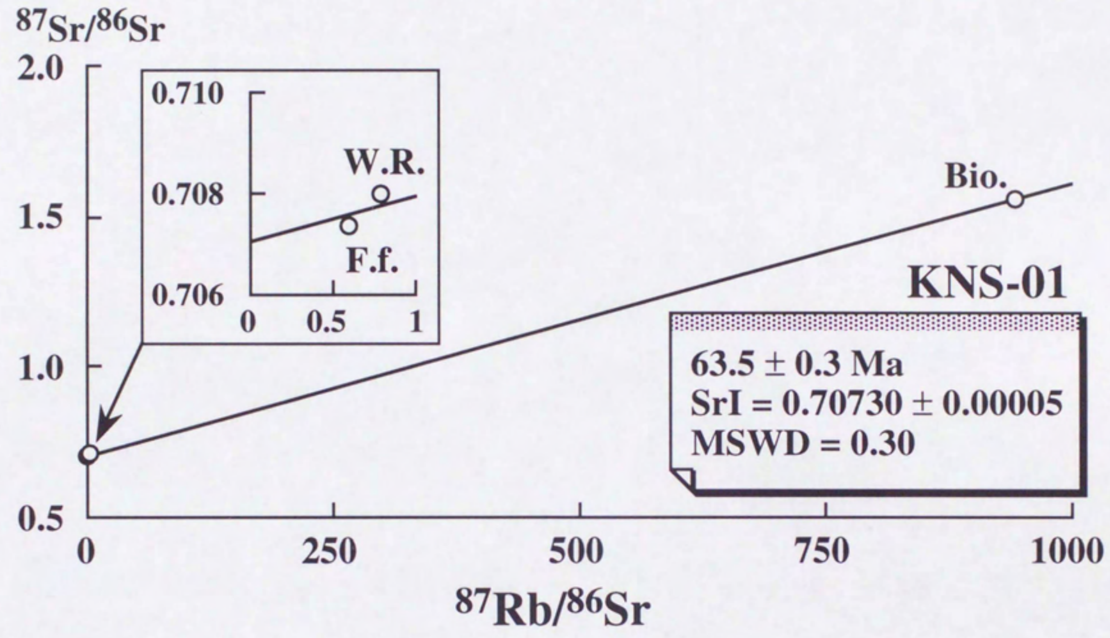


Fig.V-55 Rb-Sr whole-rock and mineral isochron for the Kiyosaki granite. Bio:biotite, F.f.:felsic fraction, W.R.:whole-rock.

Mineral samples and a whole-rock sample define Rb-Sr whole-rock and mineral isochron age of 83.8±9.6Ma(OHA-04) and 78.3±2.3Ma(OHA-05)(Fig.V-56). The age of OHA-04, which has large error, discords K-Ar hornblende age of same sample. However, age of OHA-05 agrees with K-Ar age in the range of error.

Shirotori granite

The Shirotori granite consists of seven rock types from granodiorite to granite(Kutsukake et al., 1979). This granitic body is exposed in the southern part of the Sanuki region. Kutsukake et al.(1979) defined this granite as massive granite being similar to the Hiroshima granites. K-Ar biotite ages of 83Ma, 77Ma(Kawano and Ueda, 1966) and 87.3Ma(Shibata, 1979) have been reported about this granite. Rb-Sr whole-rock isochron age of 93±28Ma (SrI=0.70745±0.00077) was reported by Kagami et al.(1988) .

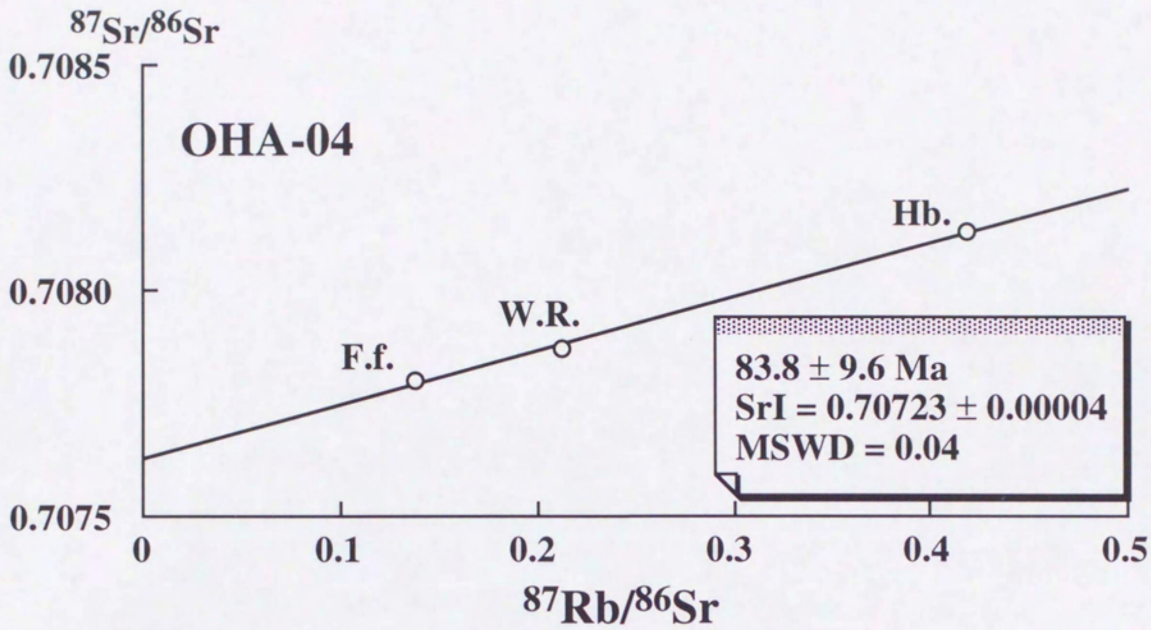
One sample(SR-01) was collected from this body. The sample locality is shown in Figure V-57. Biotite, hornblende and felsic fraction were separated from SR-01.

The Rb-Sr and Sm-Nd data of these fractions and whole-rock sample are given in Table V-29.

Mineral samples and a whole-rock sample give a Rb-Sr whole-rock and mineral isochron age of 85.1±0.04Ma(Fig.V-58). This age is within range of reported K-Ar biotite ages.

Data of Kagami et al.(1988) and SR-01 define an isochron age of 91±29Ma. The K-Ar hornblende age of SR-01, which was obtained in this study, is 93.4±0.9Ma(Table V-30). Thus, NdI of this sample is calculated presuming that age of formation of this body to be 95Ma.

D. K-Ar hornblende age



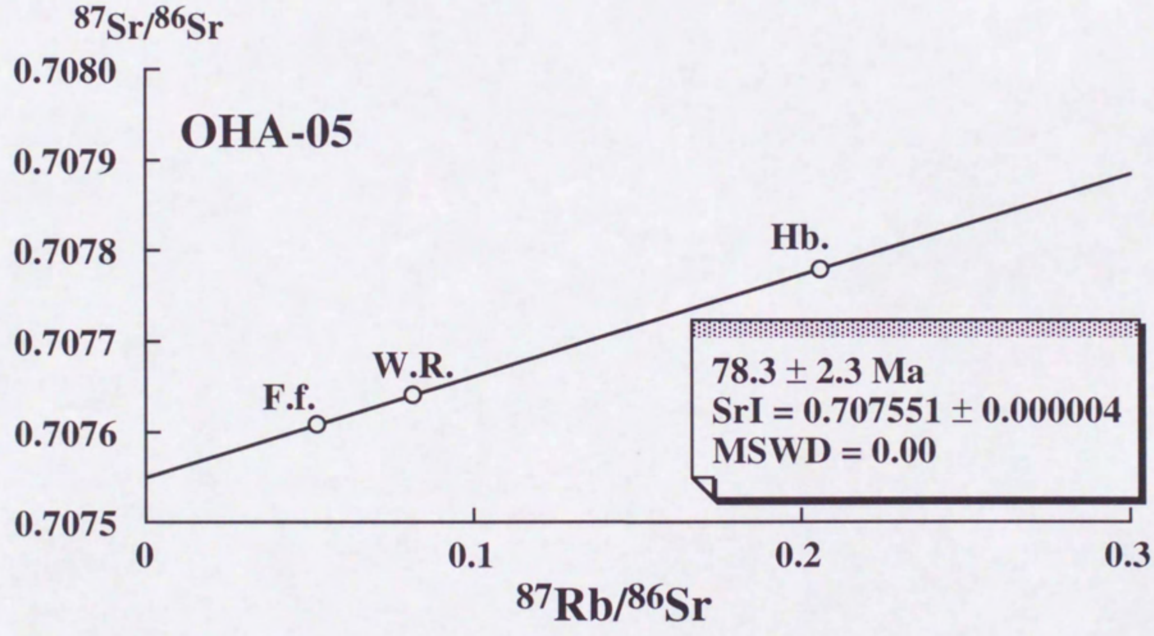


Fig.V-56 Rb-Sr whole-rock and mineral isochrons for the Ohata mass.

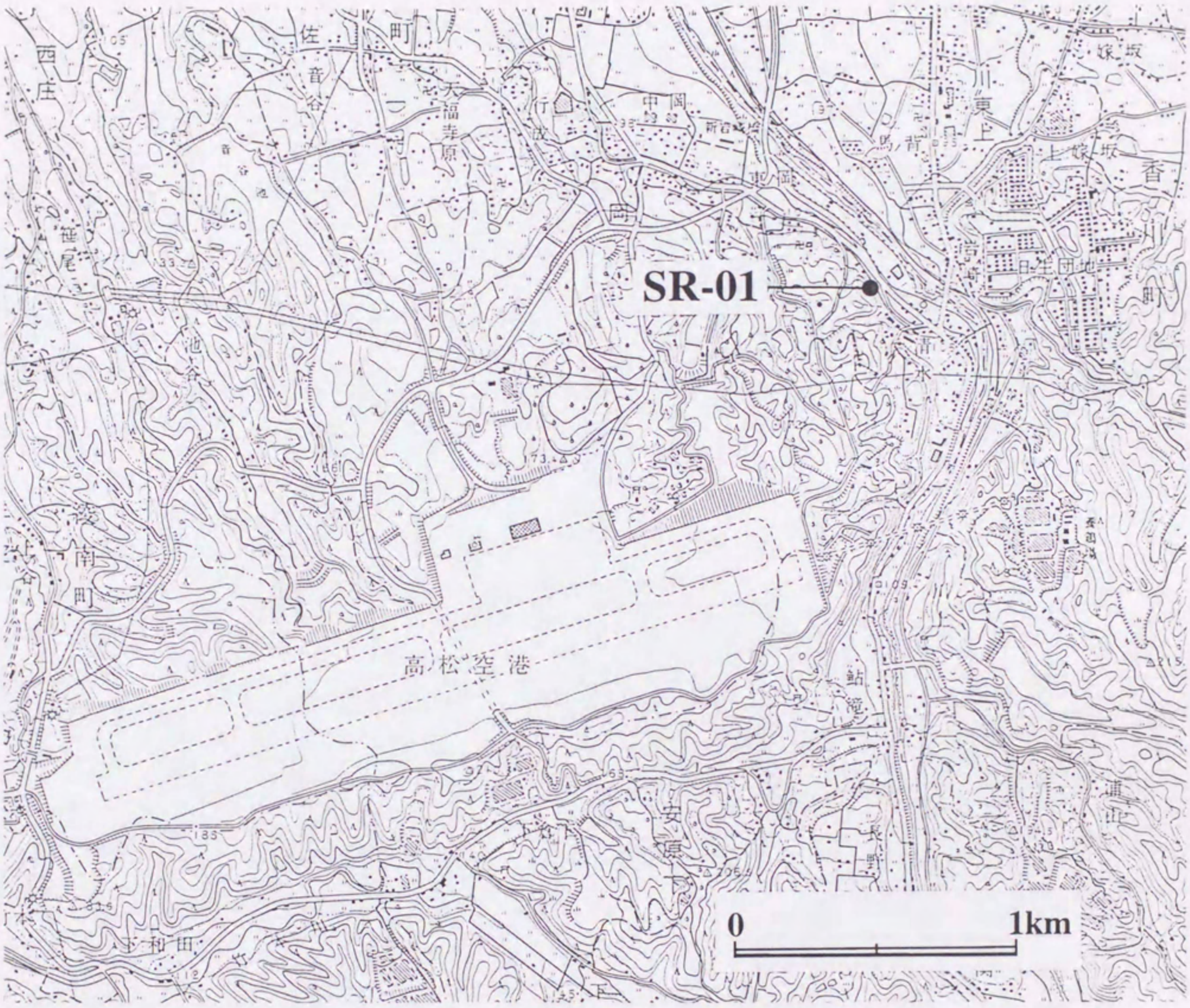


Fig.V-57 Sample locality of the Shirotori granite.
Topographic map is part of 1/25,000 map sheet "Kawahigashi" of Geographical Survey Institute of Japan.

Table V-29 Trace element concentrations and isotopic data of the Shirotori granite.

Sample No.	Rb(ppm)	Sr(ppm)	87Rb/86Sr	87Sr/86Sr(2σ)	Sm(ppm)	Nd(ppm)	147Sm/144Nd	143Nd/144Nd(2σ)	NdI*
SR-01	97.4	184	1.529	0.70967(1)	5.92	30.7	0.1166	0.512350(17)	0.512290
Biotite	353	5.55	188.0	0.93526(2)					
Felsic f.	68.7	183	1.087	0.70914(1)					

*corrected by 95Ma.

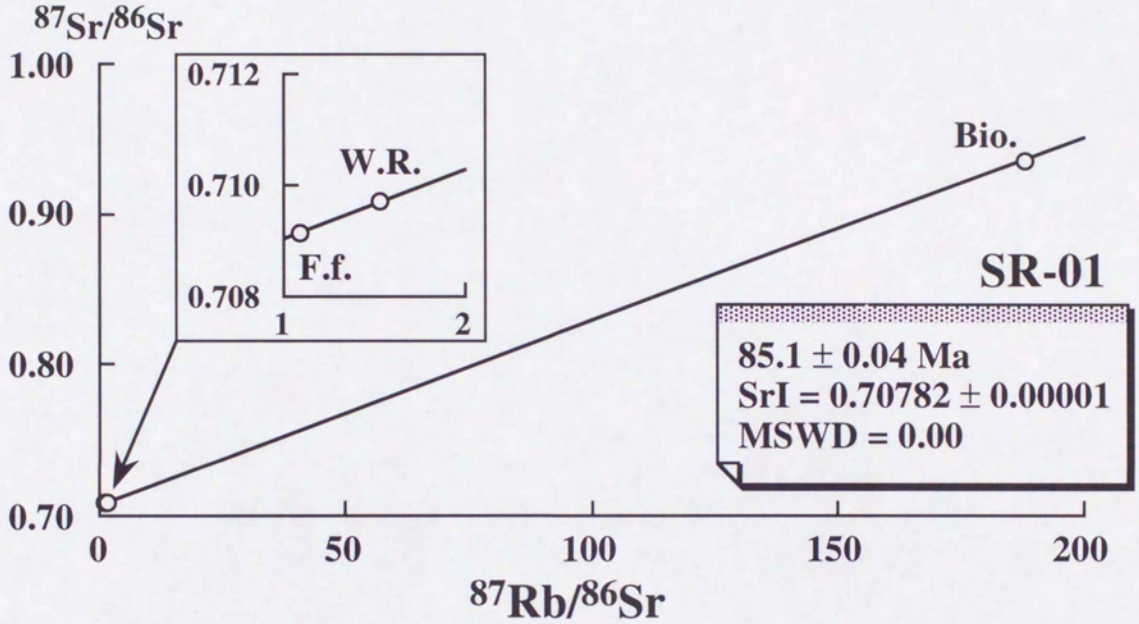


Fig.V-58 Rb-Sr whole-rock and mineral isochron for the Shirotori granite.
Bio:biotite, F.f.:felsic fraction, W.R.:whole-rock.

Table V-30 K-Ar age data of hornblende in the Ryoke granites, amphibolites and gabbros.

Sample No.	K (wt%)	36Ar (10-10cc/g)	40Ar/36Ar	40Arrad (10-8cc/g)	Age (Ma)	Air fraction (%)
Takato Gr.						
MI-17	0.2967	5.31±0.13	1732±27	76.23±0.77	64.8±0.7	17.09
	0.2984					
MI-22	0.2751	4.33±0.12	1908±36	69.99±0.70	64.1±0.7	15.51
	0.2777					
TAN-05	0.4311	4.79±0.13	2638±51	112.3±1.1	65.8±0.7	11.22
	0.4324					
TAN-27	0.2740	13.01±0.18	827.8±4.6	69.35±0.70	64.0±0.7	35.76
	0.2755					
Katsuma Qd.						
ON-27	0.3835	6.17±0.12	1937±26	101.3±1.0	66.3±0.8	15.28
	0.3890					
ON-29	0.3844	5.60±0.13	2126±34	102.6±1.0	67.1±0.8	13.92
	0.3891					
OS-11	0.3674	4.03±0.31	2553±100	96.7±2.4	66.5±1.6	11.60
	0.3678					
NA-03	0.4139	5.67±0.13	2263±37	111.6±1.2	67.9±0.8	13.08
	0.4172					
MU-08	0.3759	4.98±0.12	2304±41	100.1±1.0	67.4±0.7	12.85
	0.3749					
Kisokoma Gr.						
SHO-02	0.4151	11.27±0.17	1323±11	115.8±1.2	68.3±2.2	22.38
	0.4414					
SHO-06	0.4315	4.27±0.11	2962±57	114.2±1.1	66.1±1.0	9.99
	0.4417					
SHO-08	0.4748	4.24±0.13	3233±75	125.1±1.3	66.6±0.7	9.16
	0.4748					
OG-07	0.4795	4.27±0.12	3343±72	130.8±1.3	68.5±0.8	8.85
	0.4860					
OG-08	0.5583	7.71±0.14	2333±28	157.6±1.6	71.2±0.7	12.69
	0.5596					
OTK-20	0.5586	7.31±0.14	2342±31	150.1±1.5	67.7±0.7	12.64
	0.5620					
INA-05	0.4674	4.51±0.13	3093±65	126.1±1.3	67.6±0.9	9.57
	0.4762					
INA-07	0.5055	9.06±0.16	1788±19	135.5±1.4	68.2±0.8	16.56
	0.4986					

Table V-30 (continued).

Sample No.	K (wt%)	36Ar (10-10cc/g)	40Ar/36Ar	40Arrad (10-8cc/g)	Age (Ma)	Air fraction (%)
Amphibolite						
SN-51	0.2992	6.45±0.14	1590±23	83.74±0.87	70.5±0.7	18.61
	0.3007					
ON-34	0.7371	3.95±0.11	5396±119	203.9±2.1	69.8±0.7	5.49
	0.7390					
ON-35	0.2559	6.65±0.14	1423±18	75.05±0.76	74.2±0.8	20.80
	0.2543					
NE-02	0.7100	6.62±0.14	3051±44	183.5±1.8	65.0±0.8	9.70
	0.7194					
OG-06	0.3102	6.49±0.14	1452±21	75.21±0.76	63.2±2.0	20.39
	0.2920					
902	0.7557	7.28±0.13	3177±40	210.7±2.1	70.6±0.7	9.32
	0.7529					
MA-10	0.0770	3.68±0.12	1048±20	27.70±0.28	89.6±1.1	28.26
	0.0783					
Hiji Qd.						
ON-33	1.1914	4.83±0.12	7056±137	330.9±3.3	70.4±0.7	4.19
	1.1844					
Hissori Gr.						
KI-03	0.5843	6.06±0.13	2991±46	164.1±1.7	70.6±0.8	9.90
	0.5907					
JI-22	0.6016	4.29±0.12	4190±88	168.1±1.7	70.50.7	7.06
	0.6032					
JI-23	0.6203	5.93±0.13	3368±52	182.8±1.8	74.3±0.7	8.79
	0.6208					
Kise Gr.						
TN-45	0.4772	4.46±0.20	3152±88	127.0±1.4	67.0±0.8	9.39
	0.4817					
Gabbro						
OHA-04.2	0.2177	4.64±0.12	1465±24	54.34±0.55	63.0±0.7	20.20
	0.2190					
OHA-05.1.5	0.2606	6.24±0.14	1565±23	79.37±0.80	76.7±0.8	18.91
	0.2614					
OHA-05.2	0.2159	6.28±0.13	1309±17	63.75±0.64	74.3±0.6	22.61
	0.2168					

Table V-30 (continued).

Sample No.	K (wt%)	36Ar (10-10cc/g)	40Ar/36Ar	40Arrad (10-8cc/g)	Age (Ma)	Air fraction (%)
Ikuta Gr.						
KSB-01	1.0587	3.83±0.12	7893±189	296.2±3.0	71.0±0.8	3.75
	1.0482					
Kiyosaki Gr.						
KNS-01	0.5035	4.24±0.12	3512±76	137.2±1.4	68.6±0.8	8.43
	0.5085					
Shirotori Gr.						
SR-01	0.7104	4.25±0.13	6451±150	264.7±2.7	93.4±0.9	4.59
	0.7131					

K-Ar hornblende ages were determined for the Ryoke granite, amphibolite and gabbro. Potassium was determined by atomic absorption analysis. ^{40}Ar was analyzed by the isotope dilution method with ^{38}Ar as a tracer, using the mass spectrometer in ISEI, followed methods of Nagao et al.(1984) and Nagao and Itaya (1988). K-Ar age was calculated using the physical constant, $\lambda e=0.581\times10^{-10}y^{-1}$, $\lambda\beta=4.962\times10^{-10}y^{-1}$, $^{40}K/K=0.0001167$(Steiger and Jäger, 1977).

The result is shown in Table V-30.

VI. Discussion

A:Genesis of the migmatite

The metamorphic P-T conditions of the zone IV are temperature of about 650°C and pressure of about 4.1kb. There is not possibility that the anatexis of pelitic-psammitic metamorphic rocks took place in this condition(Yuhara et al., 1992). However, the migmatitic rocks are exposed here and here in the area east of the Tenryu River. In particular, it is widely exposed in the area near the Hissori(Fig.VI-1). However, the base of migmatitic rock does not appear because of the anticline. Migmatitic rock intrudes metamorphic rock, and cut its foliation near the Hissori Bridge(Fig.VI-2). Thus, this migmatite is the sheet-like body intruded around the boundary between zones II and III.

Migmatitic rock includes many blocks of pelitic-psammitic metamorphic rock(Fig.VI-3a). The amount of block varies. The K-feldspar megacrysts are dotted in the matrix(Fig.VI-3a,b). Further, migmatitic rock includes a block where intrafolial fold is formed. This suggests that formation or/and intrusion of migmatitic rock were after the stage D2. Further, from the major geological structure of this migmatitic body, it is thought that this intruded before the stage D4. Matrix of the migmatitic rock is foliated and composed of quarts, plagioclase, K-feldspar, biotite, muscovite, cordierite and sillimanite with accessory apatite and zircon. Sillimanite is fibrolite, and most of it is included by cordierite(Fig.VI-4). Sometimes, it forms crenulation fold. These suggest that such cordierite is derived from the metamorphic rock which has undergone metamorphism of stage M3 and deformation of stage D2. Cordierites including biotites which show preferred shape orientation, also are derived from the metamorphic rock. Further, the dispersion of direction of preferred orientation suggests that cordierite moved in melt during movement of the migmatitic rock. However, prismatic and spherical cordierite that

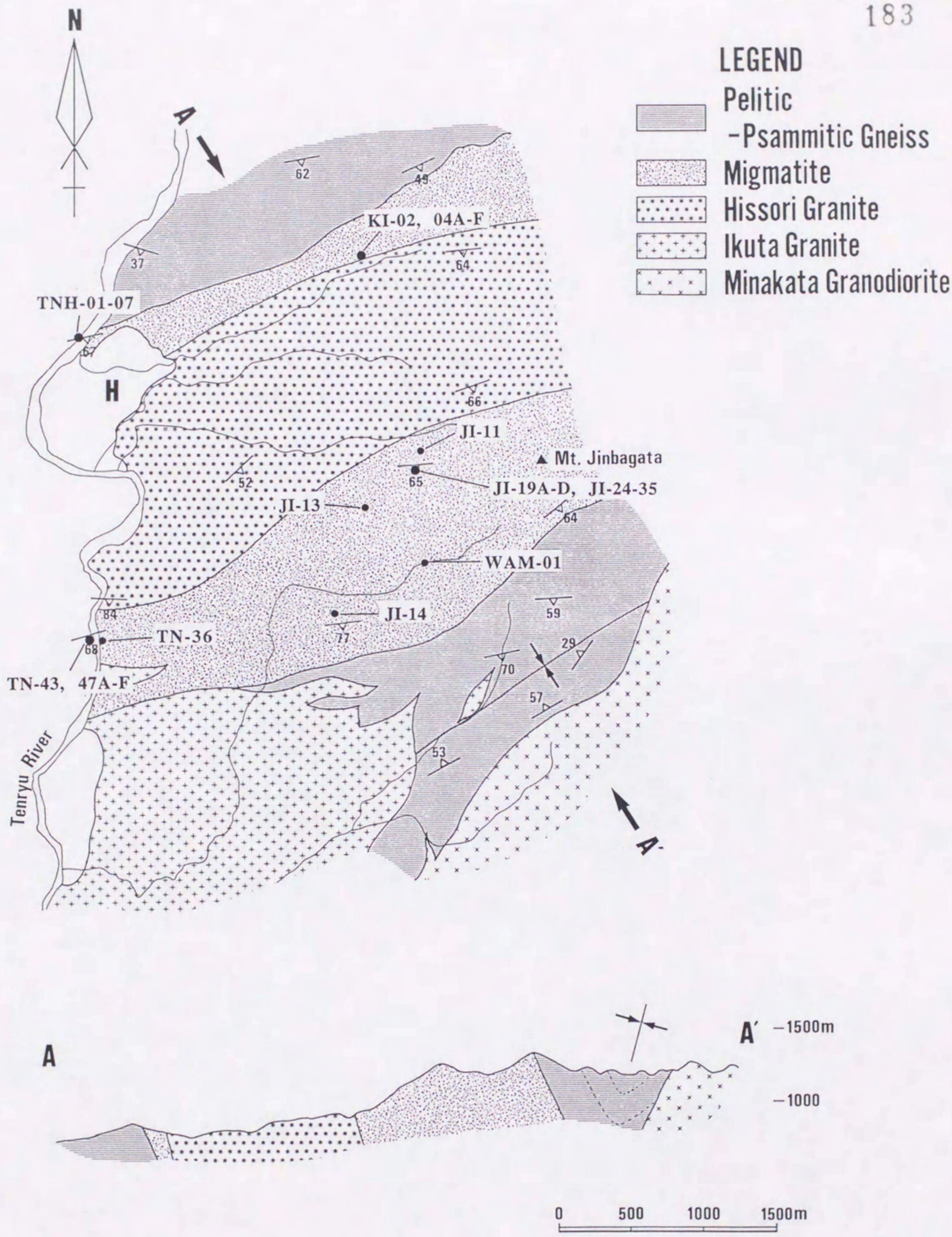


Fig.VI-1 Geological map and localities of samples of the migmatite.
H:Hissori.

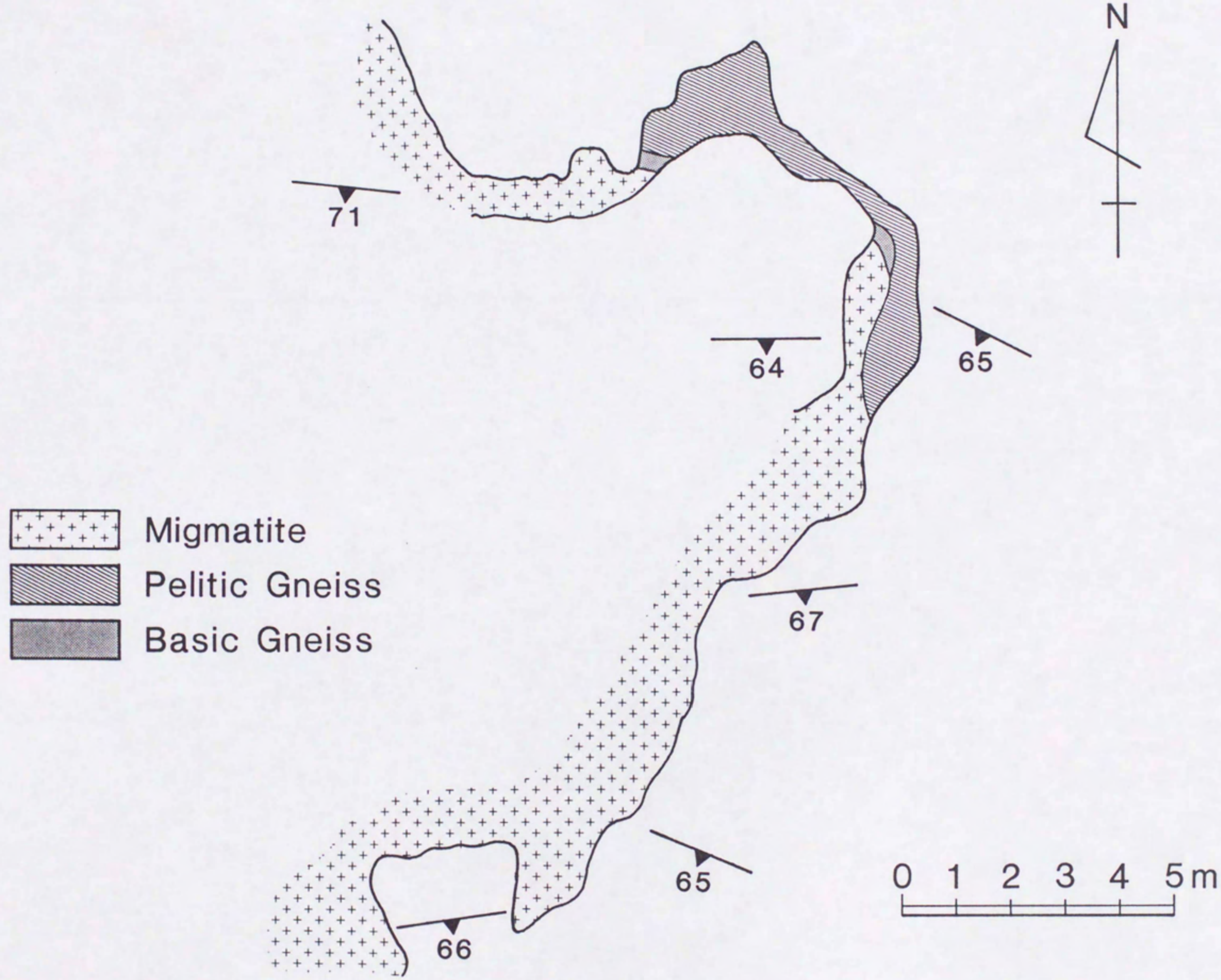


Fig.VI-2 Lithologic map of contact of the migmatite and metamorphic rocks.
(nearby the Hissori Bridge)

Fig.VI-3a Photographs of the migmatite.
Length of scale bar is 10 cm.

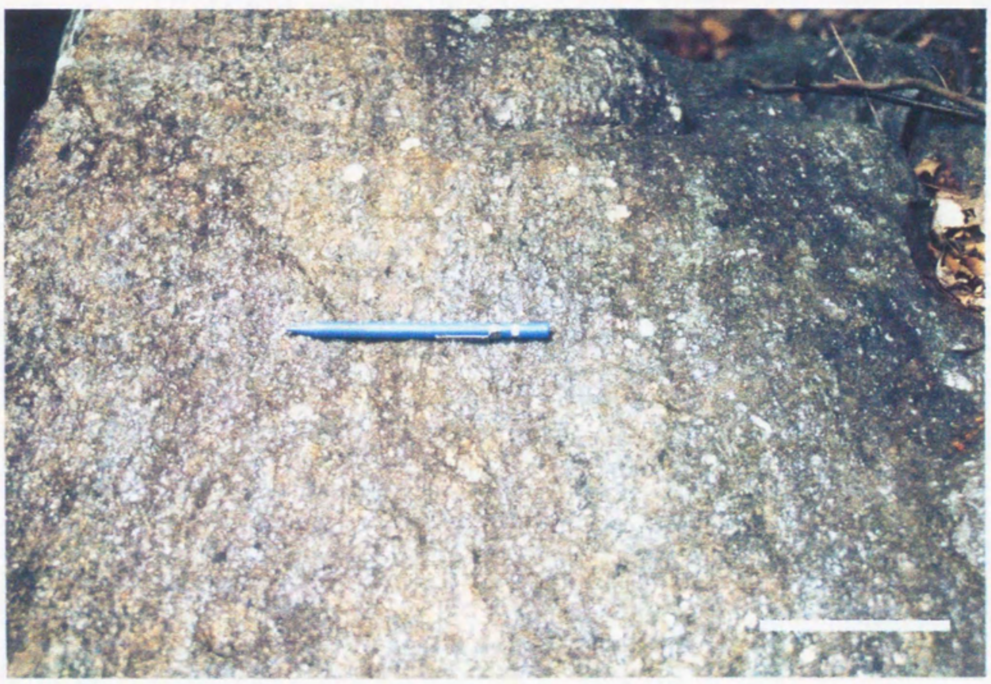


Fig.VI-3b Photographs of the migmatite.
Length of scale bar is 10 cm.

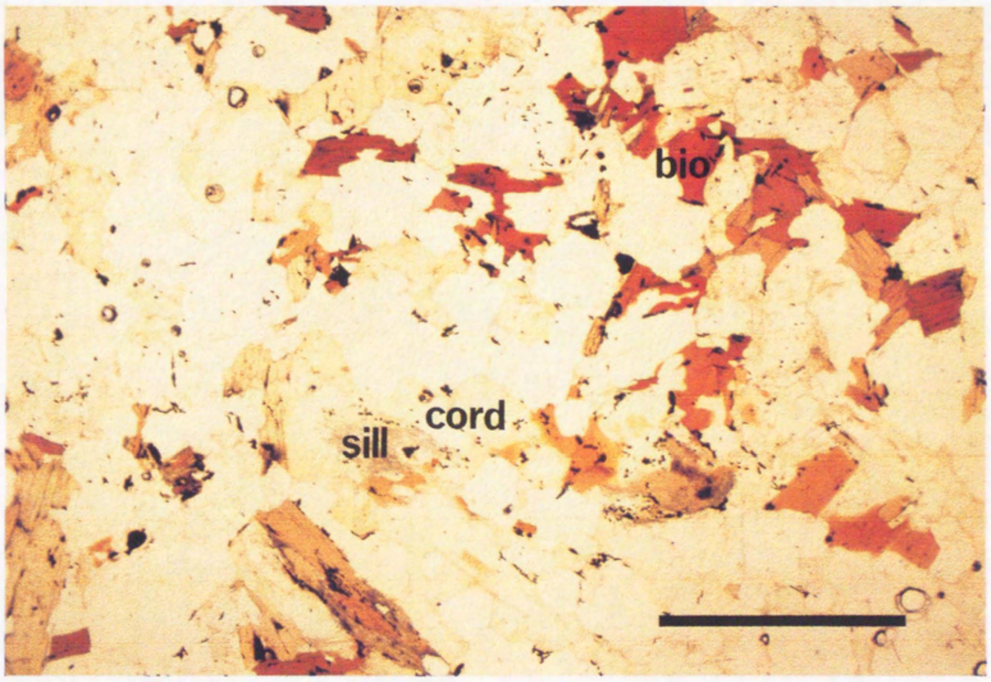


Fig.VI-4 Photomicrograph of the migmatite.
bio: biotite, cord: cordierite, sill: sillimanite.
Length of scale bar is 1 mm.

does not include such minerals. Plagioclase shows euhedral and subhedral shape with zonal structure. These minerals might crystallize from the melts. Thus, these textures suggest that the migmatites formed by mixing of melts formed by anatexis and the metamorphic rocks(restite) in the scale of mineral during movement and raise process of them. The mineral assemblage of matrix may depend on its emplace depth(cf. Shimura et al., 1992). Garnet probably disappeared during anatexis.

The whole-rock samples were collected from the migmatitic rocks(Fig.VI-1). Two of them are blocks of the metamorphic rocks.

Whole rock chemical compositions of these samples are given in Table VI-1.

SiO_2-oxides diagrams and SiO_2-minor element diagrams are given in Figures VI-5 and 6. On these diagrams, migmatitic rocks do not plot on the trend of the older Ryoke granites(Kawada and Yamada, 1957; Shibata et al., 1960; Kanisawa, 1961; Yamada, 1967; Kanisawa, 1975; Takagi, 1984; Kutsukake, 1993; and this study), but plot within the range of the pelitic-psammitic metamorphic rocks(Table VI-2). In particular, trends of CaO and Na_2O are remarkable. Rare earth element(REE) compositions of migmatitic rocks also compare with those of metamorphic rocks(Yuhara et al., 1992). Sr and Nd isotope ratios are higher and lower than ones of the granitic rocks expect the Otagiri granites, respectively. Furthermore, these ratios corrected by 100Ma are within the ranges of ones of the metamorphic rocks(Fig.VI-7). These suggest that the migmatitic rocks were formed from the metamorphic rocks.

The condition of formation of migmatitic rocks is estimated from the metamorphic conditions of metamorphic rocks that are exposed at present. The peak metamorphic P-T conditions of zone IV which is highest grade, were approximately 650°C and 4.1kb. Anatexis is greatly influenced by XH_2O besides temperature and pressure. In the Ina district,

Table VI-1 Whole-rock chemical compositions of the migmatite.

Sample No. #	TNH-01 Matrix	TNH-02 Matrix	TNH-03 Matrix	TNH-04 Block	TNH-06 Matrix	TNH-07 Matrix	TNH-08 Matrix	ON-19b Matrix	ON-20 Matrix	ON-21 Block	ON-22 Matrix	KI-02 Matrix
SiO_2	69.61	73.25	67.28	66.65	69.79	66.59	80.82	79.12	64.93	61.76	65.63	68.03
TiO_2	0.77	0.47	0.77	0.77	0.66	0.78	0.24	0.39	0.83	0.90	0.75	0.77
Al_2O_3	14.19	14.03	15.58	16.25	14.93	16.08	10.99	10.72	16.00	17.67	16.09	16.35
Fe_2O_3	0.66	0.27	0.11	0.28	0.39	0.40	0.37	0.86	2.40	0.57	0.74	0.94
FeO	4.14	2.23	4.26	4.39	3.73	3.57	1.09	2.27	3.32	5.17	4.34	3.91
MnO	0.13	0.06	0.09	0.10	0.08	0.07	0.06	0.18	0.15	0.20	0.12	0.06
MgO	1.91	1.01	1.84	2.14	1.60	1.61	0.67	1.16	2.21	2.27	1.99	2.03
CaO	0.76	1.12	1.43	2.26	1.38	0.73	1.75	0.60	1.36	1.44	1.29	1.05
Na_2O	1.49	2.30	2.41	2.91	2.36	1.73	3.03	1.12	1.77	1.76	1.62	1.80
K_2O	3.42	3.89	3.29	1.73	3.14	6.16	1.05	2.86	3.28	3.73	3.69	3.61
P_2O_5	0.06	0.09	0.12	0.12	0.14	0.12	0.12	0.09	0.08	0.07	0.15	0.10
LOI	2.38	1.45	2.41	1.90	2.06	2.40	0.74	1.08	2.59	2.89	2.63	2.39
Total	99.53	100.17	99.60	99.52	100.29	100.25	100.94	100.47	98.92	98.44	99.04	101.05
Ba	612	734	453	146	457	1013	112	565	633	783	571	
Cu	5	5	10	7	20	14	8	n.d.	36	6	35	16
Nb	17	10	14	14	12	14	4	10	12	15	14	14
Ni	51	9	28	38	29	30	8	26	31	30	29	24
Rb	170	144	142	109	128	195	40	108	125	146	137	147
Sr	142	207	214	234	202	222	181	105	211	245	197	202
Y	22	18	23	20	22	23	9	20	27	26	29	21
Zn	99	49	93	98	74	83	23		90	101	94	94
Zr	153	193	212	171	208	200	106	98	204	197	183	197

LOI: Loss on ignition, n.d.: not detected.