GSA DATA REPOSITORY 2012318

Geochemical Analytical Techniques

Two plagiogranite samples were collected from the Sheeted Dike Complex and were analysed for major and trace elements compositions using a Philips WD/XRF at the National Centre of Excellence in Geology, University of Peshawar, Pakistan. Rare Earth Elements (REE) were analyzed by a Perkin-Elmer ELAN 6100 Inductively Coupled Plasma Mass Spectrometer (ICP-MS) at the Amdel Laboratories Pty. limited, Adelaide. Australia. Major element compositions were determined on glass beads formed by mixing powder with lithium tetraborate in the 1: 4 ratios. Trace elements were determined on pressed powder pellets. Geochemical data are listed in Table DR2.

LA-ICP-MS U-Pb Zircon Analysis

Whole rock samples were crushed to a medium to coarse powder and sieved into three fractions of $\leq 75 \,\mu\text{m}$, $\geq 75 \,\mu\text{m} - \leq 425 \,\mu\text{m}$, and a $\geq 425 \,\mu\text{m}$. The $\geq 75 \,\mu\text{m} - \leq 425 \,\mu\text{m}$ fraction was panned to concentrate zircons and the resulting heavy fraction underwent a methylene iodine heavy liquid separation to produce a mineral fraction containing only those minerals with a density greater than 3.3 g cm⁻³. The resulting heavy liquid separate was washed with acetone and dried. Zircons where then hand picked and mounted in an epoxy resin (tradename \sim Epoxicure). The epoxy mounts were polished to expose the mounted minerals, carbon coated and imaged via cathodoluminescence on a Phillips XL20 scanning electron microscope. Ablation of zircons was performed with a New Wave Research Nd: YAG laser (spot size = $30 \mu m$ / frequency = 5Hz / intensity = 75% - which results in a fluence of 9-10 J/cm^2) in a He ablation atmosphere, with ${}^{206}Pb/{}^{238}U$, ${}^{207}Pb/{}^{235}U$, ${}^{207}Pb/{}^{206}Pb$ and ${}^{208}Pb/{}^{232}Th$ isotope ratios measured on an Agilent 7500 series ICP-MS. The analysis run consisted of 50 seconds of blank measurement followed by 50 seconds of measurement of ablated material. Dwell times on each isotope are: 204 Pb = 10 secs, 206 Pb = 15 secs, 207 Pb = 30 secs, 208 Pb = 10 secs, 232 Th = 10 secs, 238 U = 15 secs. Ablation and machine fractionation was corrected for against the known GJ zircon (TIMS normalisation data: 207 Pb/ 206 Pb = 608.3 Ma and 206 Pb/ 238 U = 600.7 Ma, Jackson et al., 2004). During this study we obtained 207 Pb/ 206 Pb and 206 Pb/ 238 U ages of 607 ± 20 Ma (MSWD = 1.2, n=16) and 600.1 ± 4.3 Ma (MSWD = 0.41, n=16) respectively for the GJ standard. An in-house Sri Lankan zircon standard (BJWP-1, TIMS normalising data: ${}^{206}\text{Pb}/{}^{238}\text{U} = 720.4 \pm 0.5 \text{ Ma}$) was used to check for accuracy. The BJWP standard U-Pb ages obtained in this study gave an average age of 206 Pb/ 238 U = 722 ± 13 Ma (2σ , MSWD = 1.16). Age calculations of individual zircons utilised the real-time correction program 'Glitter' (Jackson et al., 2004). Concordia diagrams and probability distribution plots where constructed using the ISOPLOT software (Ludwig, 2012).

References

- Jackson, S.E., Pearson, N.J., Griffin, W.L., and Belousova, E.A., 2004, The application of laser ablation-inductively coupled plasma-mass spectrometry to in-situ U/Pb zircon geochronology: Chemical Geology, v. 211, p. 47-69.
- Ludwig, K.R., 2012, Isoplot, A Geochronological Toolkit for Microsoft *Excel*. Berkeley Geochronology Center, Special Publication No. 5, p. 75.



Table DR1: Comparison of the new U-Pb age data with the previous ages on Muslim Bagh Ophiolite Complex

Analysed minerals or elements	Dating method	Ages	References	
Zircon	U-Pb	80.2 ± 1.5 Ma	This study	
Hornblende	K-Ar	$81.4 \pm 5.5\ 80.9 \pm$	Sawada et al., 1995	
		3.5 Ma		
Hornblende	K-Ar	67.4 ± 4 Ma	Sawada et al., 1995	
Hornblende	40 Ar- 39 Ar	70.7 ± 5 Ma	Mahmood et al., 1995	
Hornblende	40 Ar- 39 Ar	65.1 ± 4.1 Ma	Mahmood et al., 1995	
	Analysed minerals or elements Zircon Hornblende Hornblende Hornblende	Analysed minerals or elementsDating methodZirconU-PbHornblendeK-ArHornblendeK-ArHornblende40Ar-39ArHornblende40Ar-39Ar	Analysed minerals or elementsDating methodAgesZirconU-Pb 80.2 ± 1.5 MaHornblendeK-Ar 81.4 ± 5.5 80.9 ± 3.5 MaHornblendeK-Ar 67.4 ± 4 MaHornblende 40 Ar- 39 Ar 70.7 ± 5 MaHornblende 40 Ar- 39 Ar 65.1 ± 4.1 Ma	

Sample No	I-136	I-138
SiO ₂	74.75	74.2
TiO ₂	0.24	0.25
Al_2O_3	13.1	13.3
Fe ₂ O ₃	2.84	2.79
MnO	0.04	0.041
MgO	0.49	0.51
CaO	4.42	4.55
Na ₂ O	3.36	3.38
K ₂ O	0.18	0.19
P ₂ O ₅	0.03	0.031
Total	99.49	99.242
LOI	0.513	0.76
Sc	4.4	4.7
V	51.4	52
Cr	137.9	138.1
Co	34.9	35.2
Ni	2	2.3
Cu	10.9	10.9
Zn	5.8	6
Ga	23	22.5
As	0.7	0.8
Br	2.2	2.23
Rb	0.4	0.44
Sr	175.4	175.1
Y	47	4 72
Zr	77.2	77.2
Nb	1	12
Ag	15.2	14.8
Cd	10.2	10.6
Sn	16.8	16 44
Ba	92.4	93
La	8.2	9
Ce	15.8	161
Nd	1.8	1.7
Sm	0.58	0.54
Yh	0.45	0.34
Hf	22.9	23.1
Та	0.4	0.5
Bi	15.2	16
Th	65	61
Tm	0.05	0.055
Th	0.05	0.055
Pr	0.75	0.12
Но	0.75	0.72
Gd	0.51	0.2
Fu	0.55	0.44
Fr	0.72	0.04
Dv	0.4	0.5
5,	0.04	0.57

 Table DR2:
 Major (wt %) and trace element (ppm) compositions of the two samples of plagiogranite.

	Isotopic ratios			Ages				
Analysis name	Pb ²⁰⁷ /U ²³⁵	± 1σ	Pb ²⁰⁶ /U ²³⁸	± 1σ	Pb ²⁰⁷ /Pb ²⁰⁶	± 1σ	Pb ^{206/} U ²³⁸	± 1σ
SPOT1	0.08897	0.00583	0.01326	0.00031	131.7	151.01	84.9	2
SPOT2	0.15064	0.00924	0.01387	0.00038	1166.7	122.84	88.8	2.41
SPOT3	0.0986	0.00525	0.01312	0.00029	391.6	118.29	84	1.87
SPOT4	0.18412	0.01019	0.01319	0.00037	1647.3	105.79	84.5	2.33
SPOT5	0.10104	0.00474	0.01288	0.00027	487.3	103.29	82.5	1.72
SPOT6	0.21026	0.01616	0.01434	0.00055	1737.3	145.2	91.8	3.5
SPOT7	0.11006	0.00529	0.01317	0.0003	625.4	102.51	84.3	1.9
SPOT8	0.38503	0.0133	0.01604	0.00039	2597.4	60.79	102.6	2.48
SPOT9	0.2032	0.00835	0.01391	0.00032	1730.9	77.42	89	2.04
SPOT10	0.11835	0.00617	0.0129	0.0003	822.7	108.99	82.6	1.93
SPOT11	0.10747	0.0057	0.01289	0.0003	622.7	113.87	82.5	1.9
SPOT12	0.11917	0.00695	0.01279	0.00033	857	121.74	81.9	2.07
SPOT13	0.14531	0.00858	0.01287	0.00035	1244.4	117.72	82.4	2.24
SPOT14	0.10855	0.00508	0.01239	0.00027	728.1	99.18	79.4	1.73
SPOT15	0.10367	0.00273	0.01218	0.00021	666.6	53.38	78.1	1.31
SPOT16	0.08142	0.0042	0.01309	0.00027	0.1	76.14	83.8	1.74
SPOT17	0.11076	0.00594	0.0128	0.0003	702.3	114.21	82	1.92
SPOT18	0.1188	0.00674	0.01354	0.00034	731.8	120.58	86.7	2.15
SPOT19	0.10927	0.00424	0.01282	0.00025	670.5	82.45	82.1	1.61
SPOT20	0.14571	0.00575	0.01369	0.00029	1128.4	79.09	87.7	1.82
SPOT21	0.09256	0.00365	0.013	0.00025	271.4	88.57	83.3	1.58
SPOT22	0.14997	0.0054	0.01334	0.00027	1235.5	70.53	85.5	1.72
SPOT23	0.10881	0.00568	0.01239	0.00029	733.9	110.34	79.4	1.83
SPOT24	0.10353	0.00527	0.01217	0.00027	664.9	108.77	78	1.75
SPOT25	0.10108	0.00672	0.01236	0.00033	579.2	143.62	79.2	2.1
SPOT26D	0.09062	0.00518	0.01216	0.00028	374.2	127.17	77.9	1.81
SPOT27	0.20665	0.00651	0.01333	0.00027	1840.7	57.77	85.3	1.7
SPOT28	0.09826	0.00558	0.01239	0.00029	511.6	124.36	79.4	1.87
SPOT29	0.08948	0.00435	0.01244	0.00026	294.5	109.67	79.7	1.67
SPOT30	0.12835	0.00713	0.01203	0.00031	1130.7	112.16	77.1	1.98

Table DR3 - LA-ICPMS data for Muslim Bagh plagiogranites