New research on granulite xenoliths from Cenozoic volcanic rocks from northern Tibetan Plateau

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Extensive volcanism has existed on the northern Tibetan Plateau since Cenozoic Era, and more and more research has been engaged, such as Deng (1989), Arnaud et. al. (1992), and Turner et. al. (1996). During 1998 INDEPTH geologic cross section research, the geologists discovered xenoliths in some different localities; in the area of 34°22.7'N, 89°10.1'E and 33°57.4'N, 88°49.0'E, some of the xenoliths are typical granulite.

Table 1 Mineral compositions (wt%) of granulite xenoliths from the northern Tibetan Plateau.Analysed by Jiang Wan and Han Xiuling, CAMECA SX51, 15.0Kv, 20nAThe volcanic rock are bimodal, mainly moderately felsic lava flows interlayed with mafic lava flows. The felsic lavas are trachyte to trachyandesite with phenocrysts include phlogopite, plagioclase (An=35), amphibole, clinopyroxene and sanidine. The mafic lavas display typical quench texture, with abundant phenocrysts (30-45%) embedded in a glassy groundmass. According to research by Arnaud et al. (1992) and Turner et al. (1996), these volcanic rocks are post-collision shoshonitic rocks.

The granulite xenoliths are mostly hosted by the felsic lavas, and in the mafic lava, we also find some pyroxenite xenolith, but now we are not sure if they are of mantle origin.

These xenoliths contain diferrent minerals, according to the mineral assemblages, the granulite xenoliths are divided into three groups: two-pyroxene granulites (hypersthene + augite + plagioclase + pargasite), noritic granulite (hypersthene + plagioclase), felsic granulites (plagioclase + K-feldspar + quartz + garnet + hypersthene + phlogopite). Some of the xenoliths contain augite, pargasite and plagioclase, and we also think they are granulite facies xenoliths. The mineral compositions of the granulite xenolith are listed in Table 1. Using Mg and Fe partition between hypersthene and augite (Wood and Banno, 1973), the equilibration temperatures is indicated to be 1120~1200°C (assuming $Fe^{2+}=Fe_{total}$), which is a little higher than the common result.

To establish the equilibration temperature and pressure, detailed petrolographic work was done combined with BSE images. In sample 712-2, a coronal texture is set in a garnet matrix and composed of plagioclase and magnetite; Opx is adjacent to the garnet. We got an equilibration P-T of 1028°C and 1.7Gpa using the geobarometry provided by Pekins and Chipera (1985).

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Table 1 Mineral compositions (wt%) of granulite xenoliths from the northern Tibetan Plateau.

Rock type		SiO2	TiO2	Al2O3	Cr2O3	FeO	MnO	MgO	CaO	Na2O	K2O	NiO	total	Mg#
Two-pyroxene granulite 713JG2	Opx	51.50	0.15	1.62	0.04	22.28	0.55	22.18	0.90	0.03	0.02	0.07	99.34	65
	Cpx	51.03	0.37	2.70	0.10	9.33	0.30	13.74	21.04	0.42	0.00	0.01	99.04	75
	Pl	51.08	0.03	30.89	0.00	0.24	0.00	0.01	13.87	3.53	0.22	0.00	99.87	
	Am	41.34	3.10	11.70	0.18	13.47	0.15	12.75	10.99	2.68	0.95	0.06	99.37	63
Noritic granulite 712JE	Opx	49.17	0.18	1.07	0.06	31.56	1.97	14.09	1.37	0.10	0.00	0.11	99.68	44
	Pl	62.17	0.06	22.50	0.03	0.29	0.00	0.00	4.77	7.45	2.14	0.00	99.41	
Noritic granulite 713JF4	Opx	48.76	0.07	1.17	0.02	32.28	1.53	13.89	1.20	0.10	0.02	0.03	99.07	44
	Pl	62.27	0.00	22.46	0.05	0.24	0.02	0.00	4.84	7.03	2.44	0.00	99.34	
	Or	65.51	0.04	18.88	0.04	0.15	0.00	0.00	0.94	4.27	9.79	0.00	99.61	
	Phl	38.26	5.65	13.29	0.06	9.09	0.09	17.76	0.07	0.56	8.91	0.00	93.73	78
	Bi	36.47	5.37	12.80	0.10	20.59	0.24	10.91	0.03	0.49	8.62	0.00	95.63	48
Felsic granulites 712JG6	Cpx	49.68	0.51	2.86	0.05	10.69	0.23	11.51	22.90	0.35	0.00	0.01	98.79	71
	Pl	44.90	0.11	34.52	0.00	0.20	0.00	0.00	18.23	1.06	0.09	0.05	99.16	
	Phl	34.23	6.65	15.20	0.25	16.32	0.07	12.24	0.04	0.40	8.20	0.07	93.68	57
	Spe	29.78	37.16	1.85	0.11	0.52	0.11	0.03	27.60	0.02	0.00	0.00	97.07	
Felsic granulites 712-2	Opx	49.15	0.30	3.53	0.03	27.22	0.89	18.06	0.18	0.03	0.00	0.07	99.47	55
	Or	65.02	0.07	18.63	0.00	0.06	0.01	0.02	0.24	3.45	11.57	0.02	99.10	
	Phl	35.70	5.10	15.96	0.03	14.33	0.13	14.22	0.00	0.63	9.29	0.03	95.41	64
	Gt	37.25	0.00	21.41	0.02	32.41	4.34	3.87	1.34	0.05	0.00	0.11	100.8	
	Pl(rim of Gt)	58.92	0.04	24.59	0.02	0.70	0.06	0.04	7.08	6.98	1.25	0.03	99.71	
Granulites 712JB	Cpx	47.86	0.90	7.06	0.09	6.44	0.18	12.71	23.22	0.83	0.02	0.01	99.32	93
	Am	39.85	2.09	14.36	0.23	10.45	0.07	13.96	12.09	2.43	2.20	0.15	97.89	70
	Pl	56.99	0.04	26.06	0.03	0.37	0.04	0.04	9.07	5.83	0.97	0.00	99.45	

Analysed by Jiang Wan and Han Xiuling. CAMECA SX51. 15.0Kv. 20nA

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Sedimentological response to the uplifting of the West Kunlun in the Cenozoic

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The uplifting of the West Kunlun, or more exactly the relative motion between the West Kunlun and the Tarim basin, in the Cenozoic is, to a large extent, well documented by Cenozoic sediments at the northern margin of the West Kunlun.

Several regional unconformities within the Cenozoic sequence record the rhythm of uplifting; sedimentary environment change (coastal marine to lacustrine to fluviatile) notes the variation of the mountain-basin configuration; thickness and grain size of Cenozoic lithological units may reveal the amplitude and rate of the uplifting.

The formation of Cenozoic sequence took place as the transgression, which started in the Late Cretaceous was strengthened after a short period of regression at the end of the Cretaceous. As a result of that, Paleocene deposits usually rest conformably on the Cretaceous or unconformably on the Cretaceous or older strata. Since the transgression was from the west, red conglomerates and pebbly coarse sandstones in the basal part of the Paleocene are common in the eastern part. The lower part of the Paleocene is composed mainly of evaporites and red, gypsum-bearing sandstones and mudstones. The upper part of the Paleocene comprises grey fine clastics and fossiliferous carbonate intercalations. The amount of carbonates decreases eastwards and eventually disappears, and red-colored clastics become dominant.

In the early Eocene, gypsum beds and salt-bearing mudstones were formed in a wide range. By the time of the middle Eocene, the salinity of sea water gradually became normal and the transgression reached the maximum, limestones and greyish green calcareous mudstones rich in bivalves (dominated by ostreids) were formed. This is a very good index bed of the Eocene at the northern margin of the West Kunlun. In the late Eocene, sea water covered area began to reduce, more brownish and red clastics with salt and gypsum were formed.

The lower part of the Oligocene is of similar lithology as the Eocene, but large-sized bivalves become less. In the late Oligocene more and more places emerged, erosion occurred in some places. Sediments formed at this time are mainly variegated sandstones intercalated with mudstones and siltstones. By the end of the Oligocene, the marine environment ended.

The thickness of the Paleogene varies from 600 m to 1000 m, and is much smaller in comparison with that of the Neogene.

Due to the uplifting at the end of the Oligocene, the Miocene comprises entirely of continental (mainly lacustrine) deposits with red and brownish yellow colors and a thickness of 2000-3000 m. It rests in many places unconformably on the Oligocene.

The Miocene is conformably and in some places unconformably overlain by a mainly red and brownish yellow, consolidated clastic sequence which is usually referred as molasse. The molasse sequence coarsens upwards and has a thickness of 2000-3000 m. It starts with coarse sandstone and ends with conglomerate with sandstone intercalations. It is formed in a period of accelerated uplifting. The molasse and underlying Tertiary sequences are usually steeply dipped or being upright in the eastern part, and is relatively gently dipped in the western part. The molasse is unconformably overlain in many places by horizontal middle/late Pleistocene poorly consolidated or loose fluvial and pluvial pebble beds. Both middle/late Pleistocene pebble beds and older deposits are cut by latest flowing water to a depth of 50 to more than 100 m.

Judging from the deposits at the northern margin of the West Kunlun, we know that a marine environment (the Tarim embayment) was sustained from the Late Cretaceous to the Oligocene, although it had already retreated to the western part by the time of the Oligocene. Prominent uplifting occurred during the latest Oligocene. Continental environment took over in the Miocene, the large thickness of the Miocene (2000-3000 m) indicates a relatively high rate of uplifting. Rapid and accelerated rise of the West Kunlun occurred from the Pliocene to early Pleistocene: this is evidenced by the coarsening-up molasse sequence with a thickness of 2000-3000 m. The deposition of the molasse was then terminated by a strong orogenic pulse in the time of early Pleistocene, and the molasse and older Tertiary deposits are tilted. Resumed uplifting of the Kunlun after the orogenic pulse is indicated by middle/late Pleistocene pluvial and fluvial deposits which lie horizontally on molasse and older sequences. Latest uplifting is indicated by the lower position of present river beds directing northwards to the Tarim basin, which cut middle/late Pleistocene pebble beds and older deposits to a depth of 50 to more than 100 m.

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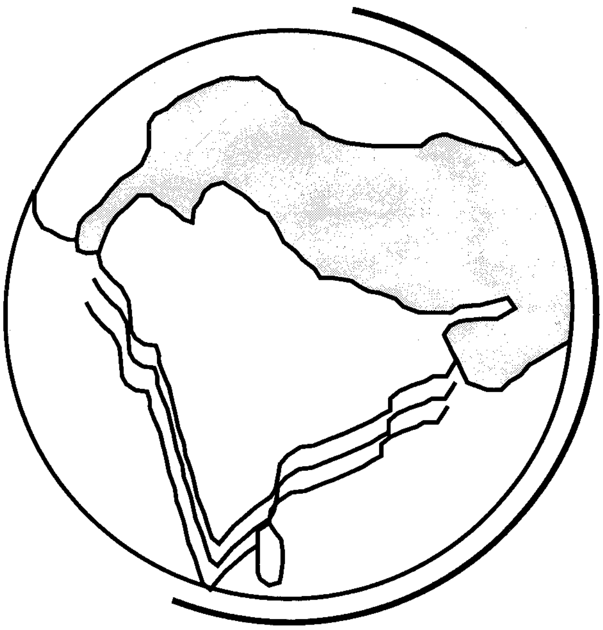

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