东天山康古尔塔格蛇绿岩 SHRIMP 年龄、Nd-Sr 同位素特征及构造意义*

李文铅[1,2] 马华东[1,4] 王冉[3] 王核[1] 夏斌[3]

LI WenQian[1,2], MA HuaDong[1,4], WANG Ran[3], WANG He[1] and XIA Bin[3]

1. 中国科学院广州地球化学研究所 成矿动力学重点实验室，广州 510640
2. 有色金属矿产地质调查中心，北京 100012
3. 中国科学院边缘海地质重点实验室，中国科学院广州地球化学研究所，广州 510640
4. 中国科学院研究生院，北京 100039

1. *Key Laboratory of Metallogenic Dynamics, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou* 510640, *China*
2. *China Non-ferrous Metals Fesource Geological Survey, Beijing* 100012, *China*
3. *Key Laboratory of Marginal Sea Geology; Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou* 510640, *China*
4. *Graduate School of the Chinese Academy of Sciences, Beijing* 100039, *China*

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Abstract The Kangguertage ophiolite in eastern Tianshan Mountain is located in the west to Tuwu-Yandong copper ore-belt and marks the Aibihu-Kangguertage suture zone between the Hasakestan plate in the north and Tarim plate in the south. The ophiolte contact in fault with Carbonic strata and form an east-west extension of tectonic slices distributed in bilateral Kangguertage major fault. SHRIMP zircon U-Pb dating for the gabbros from Kangguertage ophiolite yields an age of 494 ± 10Ma. Nd-Sr isotopic components of the gabbros, diabases, basalts, plagioclase granites and keratophyres show the variety of $\varepsilon_{Nd}(t)$ value from +5.7 to +10.5, which are consistent with the $\varepsilon_{Nd}(t)$ value of modern oceanic island-arc volcanic rocks. The $(^{87}Sr/^{86}Sr)_i$ values range from 0.703475 to 0.704923 and slightly higher than those of typical fresh modern mid-ocean ridge basalts. Thus, the Nd-Sr isotopic characteristics indicate that the Kangguertage ophiolite belongs to SSZ-type and are similar to the ophiolites in Zhungeer area. In addition, the magma was probably derived from a depleted upper mantle reservoir and didn't suffer from the contamination of the continental material. The field geotectonics, formation age and Nd-Sr isotopic component suggest that the area north of the Kangguertage major fault probably belongs to the Zhungeer plate tectonically.

Key words SSZ-type ophiolite; SHRIMP dating; Nd-Sr isotopes; Kuangguertage; eastern Tianshan

摘 要 通过对东天山康古尔塔格蛇绿岩中的辉长岩的 SHRIMP 锆石 U-Pb 年龄测定，得出康古尔塔格蛇绿岩形成于晚寒武世-早奥陶世(494 ± 10Ma)。Nd-Sr 同位素研究表明，康古尔塔格蛇绿岩中辉长岩、辉绿岩、玄武岩、斜长花岗岩及角斑岩的 $\varepsilon_{Nd}(t)$ 值变化于 +5.7 ~ +10.5 之间，与现代大洋岛弧火山岩的 $\varepsilon_{Nd}(t)$ 值一致；$(^{87}Sr/^{86}Sr)_i$ 值变化于 0.703475 ~ 0.704923 之间，与现代典型大洋中脊新鲜玄武岩的 $^{87}Sr/^{86}Sr$ 值变化范围基本一致。上述特征显示出康古尔塔格蛇绿岩与准噶尔蛇绿岩一样，属 SSZ 型蛇绿岩，其岩浆来自亏损上地幔，且在演化过程中没有受到陆源物质的明显混染。该蛇绿岩形成时代、源区组成结合区域地质构造等暗示康古尔塔格断裂以北地区可能属于准噶尔板块范畴。

关键词 SSZ 型蛇绿岩；SHRIMP 测年；Nd-Sr 同位素；康古尔塔格；东天山

中图法分类号 P597.3；P588.125

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第一作者简介：李文铅，男，1962 年生，研究员，大地构造与成矿专业，E-mail：gzwqli@gig.ac.cn

1 引言

蛇绿岩是分布在造山带中的古大洋岩石圈残片(Dewey and Bird,1971; Miyashiro,1975; Leitch,1984; Pearce *et al.*, 1984; Coleman,1984),是板块缝合带的主要标志,对于重建古构造格局、恢复造山带构造演化史具有重要地质意义,而这些研究必须建立在蛇绿岩年代学和同位素示踪等研究的基础上。最近,在东天山构造带康古尔塔格地区厘定出一套SSZ型蛇绿岩(李文铅等,2005),对于揭示中亚造山带古亚洲洋古构造格局的重建和恢复具有十分重要的意义。目前,该蛇绿岩与周边的蛇绿岩关系的对比尚没有同位素年代学和同位素示踪等基础资料,那么其与西天山巴音沟蛇绿岩(徐学义等,2005)、以及与甘肃北山蛇绿(混杂)岩带(任秉琛等,2001; 魏志军等,2004)的地质构造关系也就缺乏讨论基础。本文根据新取得的蛇绿岩辉长岩的锆石SHRIMP测试结果,蛇绿岩的Nd-Sr同位素测试结果,在确定蛇绿岩形成时代的同时,进行其源区初步的同位素示踪。综合该区古洋盆的源区背景和年代学等资料,探讨了该蛇绿岩在古亚洲洋中的大地构造归属和地质构造意义。

2 样品及分析方法

康古尔塔格蛇绿岩产出于土屋-延东铜矿带以西,标志着塔里木与哈萨克斯坦两大板块之间的艾比湖一康古尔塔格缝合带。该蛇绿岩近东西延伸,分布于康古尔塔格大断裂两侧(图1),多呈构造岩片分布于石炭系的凝灰质砂岩、凝灰质粉砂岩夹灰岩及安山岩中。其岩石组合包括变质橄榄岩、含铬铁矿蛇纹岩及尖晶石辉石岩、阳起石-绿帘石化辉长岩、斜长岩、辉绿岩玄武岩,还见有斜长花岗岩及英云闪长岩、角斑岩和放射虫硅质岩。其详细的地质特征以及岩石学、矿物学和地球化学特征见李文铅等(2005)。本文分析样品采自Ⅰ号剖面的辉长岩(样号03Q-7/1,取样位置为北纬42°12′15.2″; 东经90°53′09.4″)(图2),该岩石主要由辉石和斜长石组成,并含有少量的磁铁矿。

用常规方法从样品中分离锆石,从中挑选14颗锆石进行了U-Th-Pb含量和同位素的测定。锆石SHRIMP定年在北京离子探针中心进行,按照宋彪等(2002)描述的方法,将挑选好的锆石颗粒和标样(TEMORA1,年龄为417Ma)一起用环氧树脂制作成样品靶,经抛光、显微照相、超声波清洗和镀金后,在中国地质科学院北京离子探针中心SHRIMPⅡ型离子探针上完成U-Th-Pb同位素分析,TEMORA1和待测锆石的U、Th、Pb含量用SL13标定,而锆石U-Th-Pb同位素比值用TEMROA1标定。锆石SHRIMP U-Pb定年原理和测定流程等参见Compston等(1992)和Williams(1998)。使用的标样为TEMORA1。测试数据处理由中国地质科学院北京离子探针中心采用SQUID及ISOPLOT程序完成(Ludwig, 2002a,2002b),表1中均给出1σ误差,采用$^{206}Pb/^{238}U$比值年龄,其置信度为95%。结果列于表1。

Nd、Sr同位素组成测试在中国科学院同位素年代学和地球化学重点实验室(广州)采用多接收器等离子体质谱(MC-ICPMS)仪测定,分析方法见Zhao等(1994),$^{87}Sr/^{86}Sr$和$^{143}Nd/^{144}Nd$比值分别用$^{86}Sr/^{88}Sr=0.1194$和$^{146}Nd/^{144}Nd=$

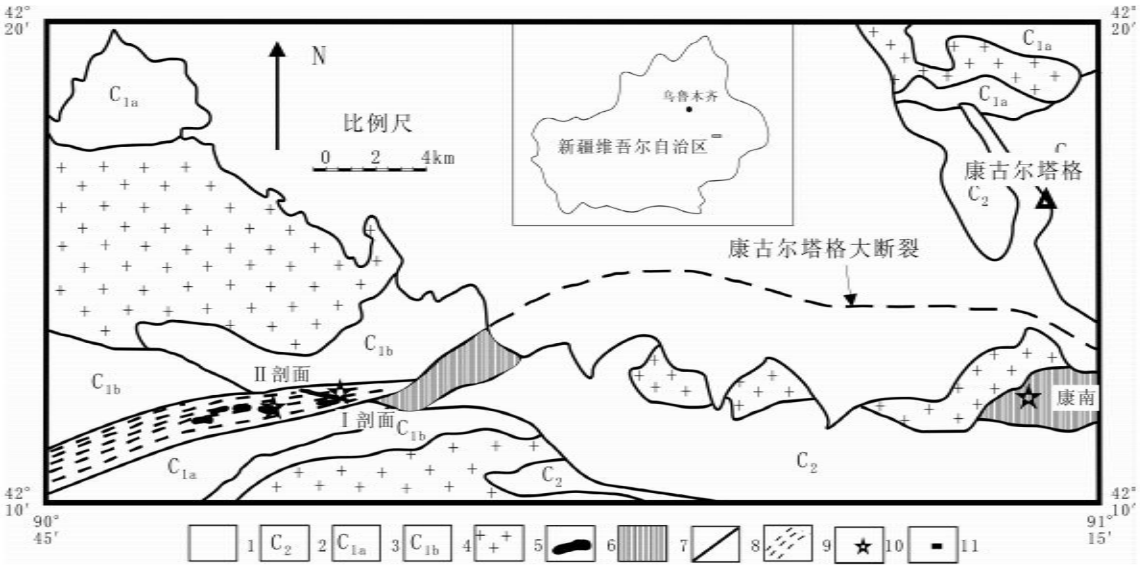


图1 康古尔塔格地区地质略图

1. 新生界; 2. 中石炭统碎屑岩; 3. 下石炭统火山岩; 4. 下石炭统碎屑岩; 5. 花岗岩; 6. 超基性岩-基性岩; 7. 玄武岩及放射虫硅质岩; 8. 深断裂; 9. 糜棱岩; 10. 采样剖面(点)位置; 11. 研究区在新疆的位置。

Fig. 1 Geological sketch map of Kangguertage area

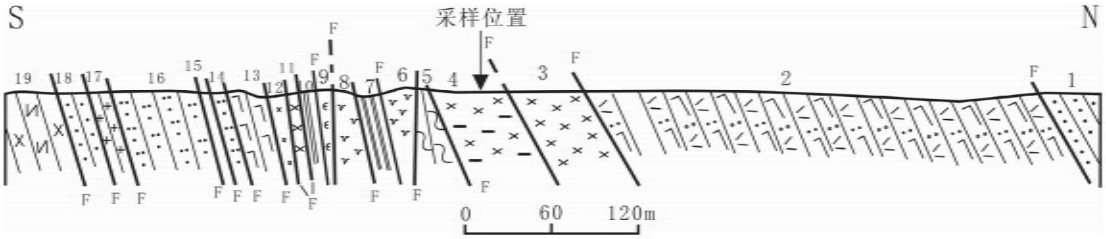


图 2 康古尔塔格蛇绿岩剖面Ⅰ

1. 变砂岩；2. 阳起石化玄武质凝灰岩；3. 浅闪石-绿帘石化石英辉长岩；4. 变质中粒角闪石英辉长岩；5. 石英绢云母千枚岩；6. 糜棱角斑岩；7. 放射虫硅质岩；8. 糜棱角斑岩；9. 含铬铁矿蛇纹岩；10－11. 阳起石-绿帘石化石英辉长岩；12. 绿泥-绿帘石化辉绿岩；13. 阳起石-绿泥石化玄武岩；14. 凝灰质砂岩；15. 磁铁矿绿泥石石英岩；16. 凝灰质砂岩；17. 灰绿色糜棱斜长花岗岩；18. 灰绿色初糜棱凝灰质长石岩屑砂岩；19. 灰绿色糜棱英云闪长岩。

Fig. 2 Geological cross-section Ⅰ of the Kangguertage ophiolite

表 1 康古尔塔格蛇绿岩中辉长岩 03Q-7/1 样品锆石 SHRIMP U-Pb 分析结果

Table 1 SHRIMP U-Pb data for zircons of sample 03Q-7/1 from massive gabbros in Kangguertage ophiolite

测点	$^{206}Pb_c$ (%)	U (ppm)	Th (ppm)	$^{232}Th/^{238}U$	$^{206}Pb^*$ (ppm)	$^{206}Pb/^{238}U$ Age	±1σ	$^{207}Pb^*/^{206}Pb^*$	±%	$^{207}Pb^*/^{235}U$	±%	$^{206}Pb^*/^{238}U$	±%
1.1	0.77	701	272	0.40	47.7	492	12	0.0519	2.5	0.563	3.5	0.0787	2.4
2.1	0.61	722	227	0.32	50.7	506	12	0.0517	2.1	0.579	3.2	0.0812	2.4
3.1	0.66	502	144	0.30	35.2	506	12	0.0527	2.7	0.589	3.7	0.0811	2.5
4.1	1.14	427	174	0.42	30.8	520	13	0.0501	3.9	0.575	4.6	0.0832	2.5
6.1	2.18	132	40	0.31	8.84	482	15	0.0423	12	0.444	13	0.0763	3.1
8.1	0.28	1037	426	0.42	71.7	499	12	0.0557	1.7	0.617	3.0	0.0803	2.4
9	0.53	179	58	0.33	12.4	491.4	9.4	0.0631	2.7	0.693	3.3	0.0797	1.9
10	1.03	168	56	0.34	11.5	487.2	9.4	0.0634	3.4	0.688	3.9	0.0787	1.9
11	4.75	37	9	0.25	2.67	499	14	0.0470	39	0.520	39	0.0800	3.3
12	3.65	41	8	0.21	3.33	549	18	0.0670	15	0.840	16	0.0903	3.2
13	0.82	153	41	0.27	9.94	464	11	0.0618	5.6	0.639	6.1	0.0749	2.4
14	0.44	399	106	0.27	28.5	512.6	9.2	0.0589	1.7	0.672	2.4	0.0828	1.8
15	0.14	437	142	0.34	29.3	481.6	9.2	0.0591	3.0	0.634	3.5	0.0778	1.8
16	0.46	1305	677	0.54	106	586	14	0.0576	1.7	0.750	2.7	0.0945	2.2

注：$^{206}Pb_c$表示普通铅^{206}Pb占^{206}Pb的百分数，Pb^*表示放射性成因铅；标准校正值的误差为0.38%。

0.7219 校正。Sr 标样 NBS987，测定结果为$^{87}Sr/^{86}Sr$ = 0.710250；Nd 标样 Shin Eston Jndi-1，测定结果为$^{143}Nd/^{144}Nd$ = 0.512115。

3 分析结果

3.1 SHRIMP 锆石 U-Pb 年代学

由于样品粉碎的原因，分离出的锆石多为形态不完整的颗粒，锆石呈不规则粒状。阴极发光(CL)图像(见图 3)显示锆石呈短柱状自形晶，具环带或条带结构，属典型的岩浆锆石。

从表 1 的 SHIRIMP 分析数据可以看出，辉长岩中锆石 U、Th 含量变化大，分别介于 37～1305μg/g 和 8～677μg/g 之间，Th/U 比值变化于 0.21～0.54 之间，平均值为 0.34，并显示出良好的正相关关系，表明所测定的锆石都是从岩浆中结晶形成的(Pidgeon 等，1988；Claesson 等，2000)。同时由表 1 中看到，锆石各测点的 U、Th 含量及 Th/U 比值与其年龄大小无相关性。因而锆石年龄可以代表岩体的形成时代。

14 个分析点中有二个测点(03Q-7-1.16、03Q-7-1.12)分别给出了 586±14Ma 和 549±18Ma 的较高年龄值，除这两点外，其余所有的测点均分布在谐和线附近，形成密集一簇

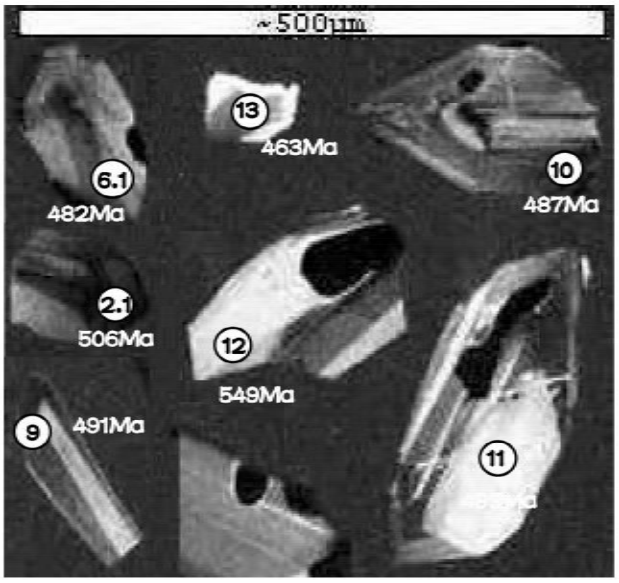


图3 康古尔塔格蛇绿岩中辉长岩的锆石阴极发光照片

Fig. 3 CL image for zircon from massive gabbros in Kangguertage ophiolite

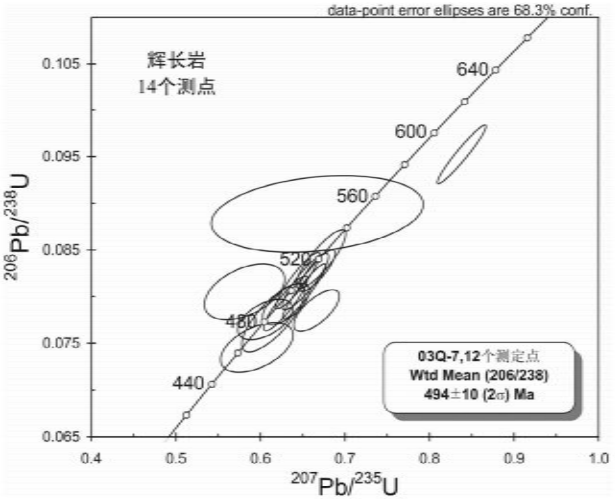


图4 康古尔塔格蛇绿岩中辉长岩锆石 U-Pb 年龄谐和曲线图

Fig. 4 U-Pb concordia diagram for zircons from massive gabbros in Kangguertage ophiolite

(图4)。剔除03Q-7-1.16、03Q-7-1.12后,12个测点计算得到$^{206}Pb/^{238}U$比值的加权平均年龄为494±10(2σ)Ma(MSWD=1.9)。如果剔除03Q-7-1.16,则13个测点计算得到$^{206}Pb/^{238}U$比值的加权平均年龄为496±11(2σ)Ma(MSWD=2.5)。二者在误差范围内是一致的。因此笔者认为12个测点的加权平均年龄494Ma应该代表辉长岩的结晶年龄,即SHRIMP锆石定年表明该辉长岩形成于晚寒武世。

3.2 Nd-Sr 同位素特征

3.2.1 Nd 同位素特征

康古尔塔格蛇绿岩的Nd、Sr同位素分析值及特征见表2。所有样品(包括2个辉长岩、3个玄武岩、2个斜长花岗岩和1个角斑岩)的Nd含量在4.27~19.41μg/g之间,$^{147}Sm/^{144}Nd$比值为0.1421~0.2442,$^{143}Nd/^{144}Nd$)在0.512842~0.513328之间。以辉长岩的锆石SHRIMP U-Pb年龄494Ma计算$\varepsilon_{Nd}(t)$值,其值的范围为+5.7~+10.5,与SiO_2含量不相关。这显示该蛇绿岩$\varepsilon_{Nd}(t)$高,且较均一,变化小,包括酸性组分在内皆如此,表明它们来自类似于MORB的亏损型地幔源,受俯冲洋壳携带的陆源物影响不明显,它们被认为是SSZ型蛇绿岩的特征,形成于俯冲带的弧间、弧前或弧后盆地中,如Samail(McCulloch等,1980)、Bay of Island(Jenner等,1991; Jacobsen等,1979)、Jabal al Wask、Jabal Ess(Claesson等,1984)和赣东北等蛇绿岩(Zhou,1989)。图5显示出自早古生代以来几个不同时代的典型蛇绿岩的Nd同位素特征,从图中可以看出康古尔塔格蛇绿岩Nd同位素组成与Bay of Islands蛇绿岩完全一致,亦暗示它们属SSZ型。

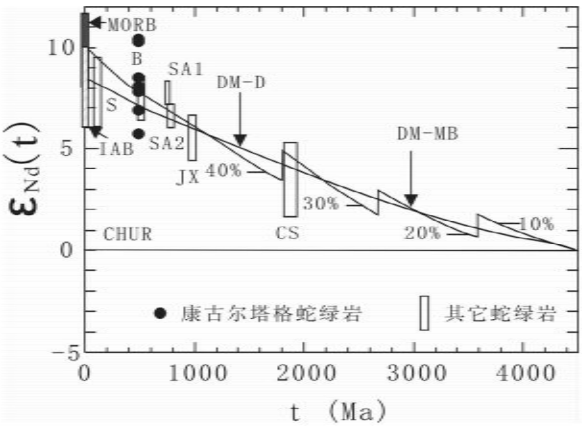


图5 康古尔塔格蛇绿岩和其他地区不同时代蛇绿岩$\varepsilon_{Nd}(t)$-t图解

CHUR-球粒陨石原始地幔演化曲线; DM-D-DePaolo(1981)提出的亏损地幔演化曲线; DM-MB-McCulloch等(1994)提出的多阶段梯状亏损地幔演化曲线; 其中10%、20%、30%、40%分别代表不同阶段的亏损地幔占整个地幔的体积比; MORB-现代洋中脊玄武岩的$\varepsilon_{Nd}(t)$值变化区间(+8~+12); IAB-现代岛弧玄武岩的$\varepsilon_{Nd}(t)$值变化区间(+6~+10); CS-魁北克Cape Smith蛇绿岩(Ernst Hegner等,1991); JX-赣东北蛇绿岩(Zhou, 1989; Li等1997); SA1、SA2-沙特阿拉伯Jabal al Wadk和Jabal Ess蛇绿岩(Claesson等,1984); B-Bay of Islands蛇绿岩(Jenner等,1991; Jacobaen等,1979); S-Samail蛇绿岩(Pearce等1981; McCulloch等,1980)

Fig. 5 $\varepsilon_{Nd}(t)$-t diagrm for Kanggurtage ophiolites and the ophiolites with different age from various regions of the world

表 2　康古尔塔格蛇绿岩 Nd-Sr 同位素分析结果

Table 2　Nd-Sr isotopic compositions for Kangguertage ophiolite

样品号	岩石名称	Rb (ppm)	Sr (ppm)	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	2σ	$(^{87}Sr/^{86}Sr)i$	Sm (ppm)	Nd (ppm)	$^{147}Sm/^{144}Nd$	$^{143}Nd/^{144}Nd)$	2σ	$\varepsilon_{Nd}(0)$	$f_{Sm/Nd}$	$\varepsilon_{Nd}(t)$	T_{DM} (Ga)
03Q-8/1	角斑岩	31.68	273.4	0.329	0.706266	16	0.703916	4.561	19.41	0.1421	0.512856	12	4.3	-0.28	7.7	0.63
03Q-5/1	斜长花岗岩	5.989	85.7	0.198	0.705411	14	0.703993	2.667	9.733	0.1657	0.512890	11	4.9	-0.16	6.9	0.83
03Q-5/2	斜长花岗岩	3.987	69.6	0.162	0.704618	16	0.703457	2.551	9.19	0.1678	0.51295	10	6.1	-0.15	7.9	0.66
03K-1/12	辉绿岩	0.831	272.6	0.009	0.704815	17	0.704753	2.668	6.623	0.2435	0.513319	11	13.3	0.24	10.3	0.86
03K-1/13	辉绿岩	0.830	196.6	0.012	0.704773	14	0.704688	2.726	6.748	0.2442	0.513328	12	13.5	0.24	10.5	0.89
03Q-6/3	玄武岩	2.364	561.8	0.012	0.704382	14	0.704297	3.853	13.75	0.1694	0.512842	11	4.0	-0.14	5.7	1.06
03Q-7/1	辉长岩	0.673	177.7	0.011	0.704999	16	0.704922	1.443	4.265	0.2045	0.513100	11	9.0	0.04	8.5	0.83
03Q-7/2	辉长岩	1.511	119.6	0.036	0.704545	17	0.704289	2.641	7.475	0.2136	0.513108	10	9.2	0.09	8.1	52.61

$T_{DM}=1/\lambda??\ \ln\{1+[(^{143}Nd/^{144}Nd)_s-(^{143}Nd/^{144}Nd)_{DM}]/[(^{147}Sm/^{144}Nd)_s-(^{147}Sm/^{144}Nd)_{DM}]\}-1$

式中$(^{143}Nd/^{144}Nd)_{DM}=0.51315$，$(^{147}Sm/^{144}Nd)_{DM}=0.2137$，$\lambda?=0.00654/Ga$　S-样品，DM-亏损地幔；康古尔塔格蛇绿岩中辉长岩年龄 t = 494Ma

3.2.2　Sr 同位素特征

康古尔塔格蛇绿岩 8 个样品的 Rb/Sr 比值都很低，Rb 含量在 0.673 ~ 31.68ppm 之间，Sr 含量在 69.6 ~ 561.8ppm 之间，其$(^{87}Sr/^{86}Sr)_i$值变化范围却不是很大（0.703475 ~ 0.704923）（表 2），除 03K-1/12 和 03K-1/13 两个玄武岩及 03Q-7/1 辉长岩的$(^{87}Sr/^{86}Sr)_i$值略高于现代典型大洋中脊新鲜玄武岩的$(^{87}Sr/^{86}Sr)_i$值 0.70230 ~ 0.70440 外，其余均在现代典型大洋中脊新鲜玄武岩的$^{87}Sr/^{86}Sr$值变化范围内，但普遍偏高端，而且与 SiO_2、MgO、Rb、Sr 含量不具相关性。这种情况在许多蛇绿岩中常见，并被认为是海水蚀变的结果（图 6）（McCulloch 等，1980；Jacobaen 等，1979）。

所有研究的样品在$\varepsilon_{Nd}(t)$对$(^{87}Sr/^{86}Sr)_i$图解中，全部落在亏损源区（图 7），说明它们的母岩浆可能为亏损地幔经部分熔融而形成的。从图中可以看到$\varepsilon_{Nd}(t)$变化小，而$(^{87}Sr/^{86}Sr)_i$变化大，并且$\varepsilon_{Nd}(t)$值不随$(^{87}Sr/^{86}Sr)_i$值的增大而降低。进一步显示了$(^{87}Sr/^{86}Sr)_i$值的变化可能是海水蚀变的结果，而不是地壳物质加入所引起的（DePaolo，1988）。

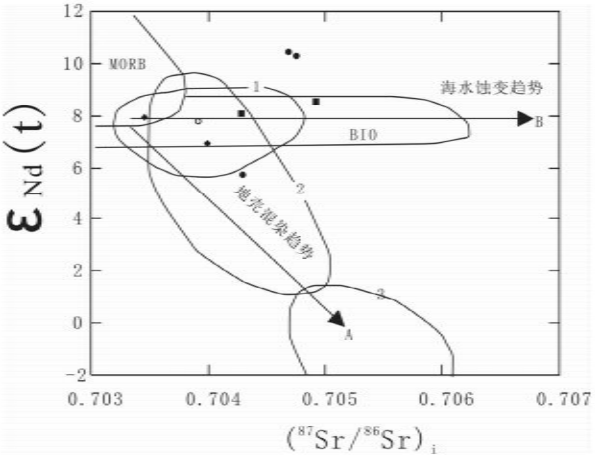


图 6　康古尔塔格蛇绿岩 $\varepsilon_{Nd}(t)-(^{87}Sr/^{86}Sr)_i$ 关系图

MORB-洋中脊玄武岩；BIO-Bay of Islands 蛇绿岩（Jenner 等 1991；Jacobsen 等 1979）；A-地壳混染趋势；B-海水蚀变趋势；1-New Britain、Marianas、Aleutians 和 South Sandwich；2-Izu Honshu；3-Sunda（Arculus，1986）

Fig. 6　$\varepsilon_{Nd}(t)-(^{87}Sr/^{86}Sr)_i$ diagram of ophiolite in Kangguertage

4　构造意义

为便于康古尔塔格蛇绿岩与古亚洲洋其他蛇绿岩同位素组成的对比，胡霭琴等（2003）将新疆北部各大陆地块（地体）大陆地壳 Nd 同位素组成特征汇编并显示于图 8 中。由图 8可以明显看到准噶尔地体中基底岩石（片麻岩、片岩类岩石）具有高的 Nd 同位素比值和年轻的 Nd 模式年龄（T_{DM}值分布在 0.7 至 1.4Ga 之间，多数为 0.7 ~ 1.0Ga），与塔里木、天山有明显的区别，结合其地球化学特征综合研究结果说明，东、西准噶尔的基底具有年轻岛弧组合的特征（Hu 等，2000；胡霭琴等，2003）。康古尔塔格蛇绿岩的样品点落在准噶尔蛇绿岩和具有高$\varepsilon_{Nd}(t)$值的花岗岩范围内，与天山、塔里木北缘大陆地壳岩石的演化范围完全不同，说明康古尔塔格蛇绿岩的母岩浆源区岩石来源于与准噶尔蛇绿岩有类似的 Nd 同位素组成的源区（图 8）。

从时代上来看，新疆北部不同地区不同构造带蛇绿岩时代有明显的差异，最新的蛇绿岩精确测年数据标注于图 9。康古尔塔格蛇绿岩与其西部的北天山巴音沟蛇绿岩形成时代（斜长花岗岩 SHRIMP 锆石 U-Pb 年龄 324.8 ± 7.1Ma，徐学义等，2006）相差甚远，而与阿尔曼太兔子泉蛇绿岩形成时

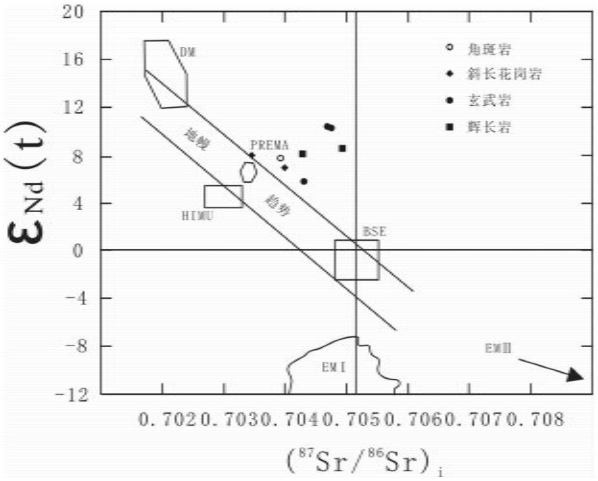


图7 $\varepsilon_{Nd}(t)$对$(^{87}Sr/^{86}Sr)_i$同位素相关图解

(仿 Zindler 等,1986) DM-亏损地幔; BSE-全硅酸盐地球; EMⅠ和 EMⅡ-富集地幔; HIMU-具高 U/Pb 比值的地幔; PREMA-经常观测到的普通地幔。

Fig. 7 $\varepsilon_{Nd}(t)$ vs $(^{87}Sr/^{86}Sr)_i$ isotope correlation diagram (after Zindler *et al.*, 1986)

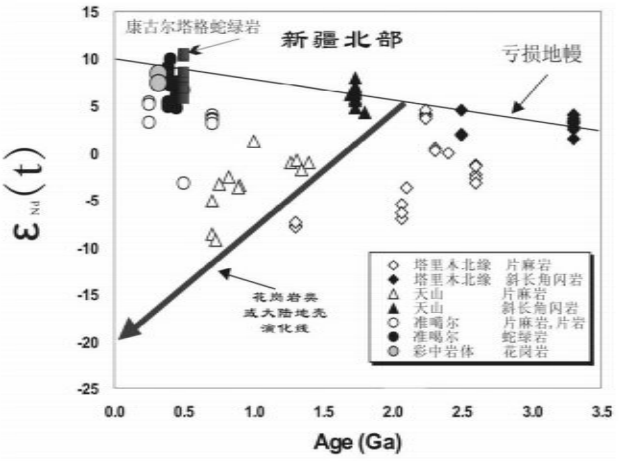


图8 康古尔塔格蛇绿岩的$\varepsilon_{Nd}(t)$-t 演化图(原图引自胡霭琴等,2003)

Fig. 8 $\varepsilon_{Nd}(t)$ – t diagram for the Kangguertage ophiolite (after Hu aiqin *et al.*, 2003)

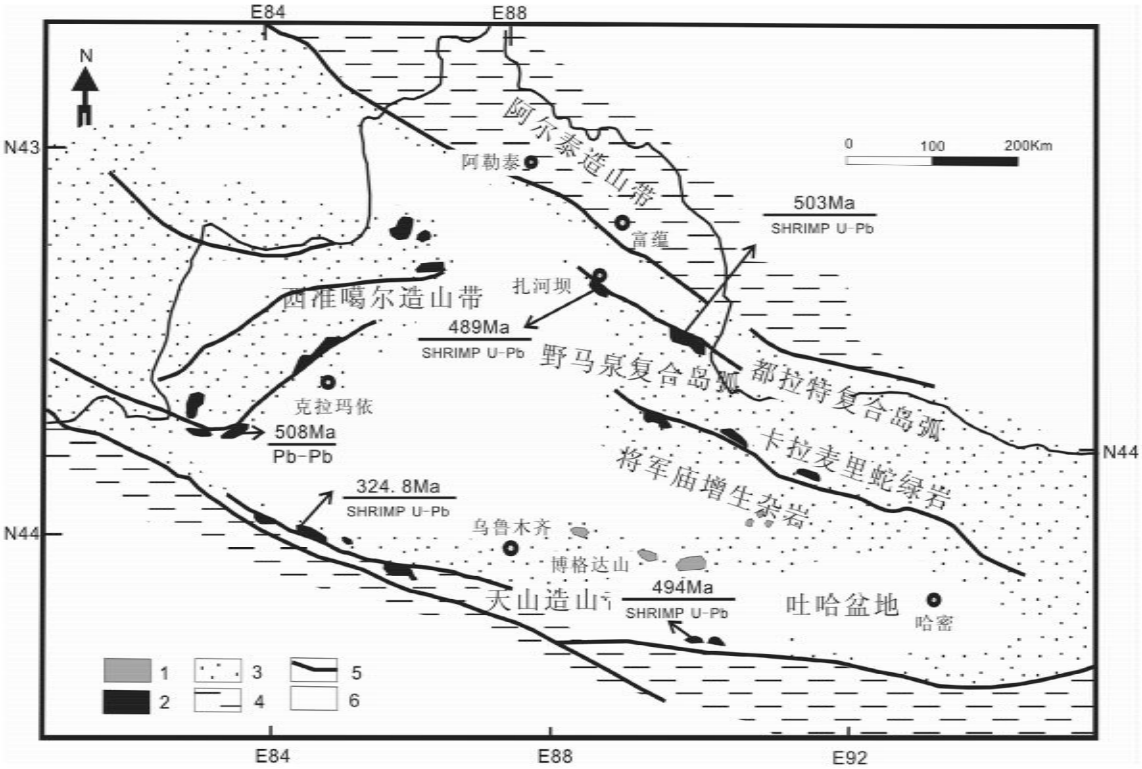


图9 东准噶尔造山带大地构造图及蛇绿岩精确测年数据 (据肖文交等,2006 及其引文修改,蛇绿岩时代和引文见正文)

Fig. 9 Tectonic map of the East Junggar orogenic belt (modified from Xiao Wenjiao *et al.*, 2006 and references therein, the formation ages of ophiolites and references see in the paper)

代(斜长花岗岩锆石 SHRIMP U-Pb 年龄为 503 ± 7Ma,肖文交等,2006)和扎河坝蛇绿岩形成时代(层状辉长岩的 SHRIMP 锆石 U-Pb 年龄为 489 ± 4Ma,简平等,2003)非常相近,并与唐巴勒蛇绿岩形成时代相近(穿插于辉长岩中的斜长花岗岩脉榍石 Pb/Pb 同位素年龄值为 508Ma,汤耀庆等,1994)。这些结果的对比表明在误差范围内,康古尔塔格地区和准噶尔一样存在的晚寒武世洋壳。但是,康古尔塔格尽管在空间位置上与巴音沟、达拉布特-卡拉麦里-塔克扎勒石炭-晚泥盆世蛇绿岩相邻,却在时代上难以对比。根据实际资料,我们初步认为在早古生代,古亚洲洋中存在康古尔塔格岛弧火山岩组成洋内俯冲体系。该洋内俯冲体系与东准噶尔岛弧火山岩组成洋内俯冲体系(肖文交等,2006)一样,可能具有类似东南亚多岛海古地理格局(Hall,2002),并在晚古生代向南拼贴到塔里木地块北缘,形成科迪勒拉型俯冲边缘(Windley *et al.*,2002; Xiao *et al.*, 2004a)。

综上所述,本文初步得出以下几点认识:

(1) 辉长岩的 SHRIMP 锆石 U-Pb 定年表明,康古尔塔格蛇绿岩形成于晚寒武世,表明东天山康古尔塔格地区在早古生代发育有古洋盆。

(2) 康古尔塔格蛇绿岩的 Nd-Sr 同位素特征表明,它们与唐巴勒蛇绿岩及阿尔曼太蛇绿岩一样,属 SSZ 型蛇绿岩。

(3) 康古尔塔格蛇绿岩无论是从形成时代,还是从源区特征方面均与准噶尔的唐巴勒蛇绿岩及阿尔曼太蛇绿岩相似,表明康古尔塔格断裂以北地区可能属于准噶尔板块范畴。它与东准噶尔造山带一道记录了古亚洲洋及其各古地理单元的演化历史。

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