

青藏高原北部东昆仑南缘德尔尼蛇绿岩：  
一个被肢解了的古特提斯洋壳

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摘要：青藏高原北部东昆仑德尔尼蛇绿岩由变质橄榄岩、基性超基性堆晶岩、辉绿岩墙群和基性喷出岩组成。变质橄榄岩主要为纯橄岩、方辉橄榄岩、二辉橄榄岩、含长二辉橄榄岩和含石榴石二辉橄榄岩，岩石中残余尖晶石的Cr'值 ( $=100 \times Cr/(Cr+Al)$ ) 为30~57，Mg'值 ( $=100 \times Mg/(Mg+Fe^{2+})$ ) 为50~75，指示一个富Al和Mg成分系列。变质橄榄岩有一个相对窄的成分，其Mg'值为89.1~91.3，Al<sub>2</sub>O<sub>3</sub>含量1%~4%，REE轻度亏损，表明其为经历了中、低程度部分熔融的残余地幔物质。含石榴石二辉橄榄岩中的石榴石为钙铁榴石，富Ca和Fe，贫Mg和Al (And 95%~97%，Pyr 0.27%~5.06%，Gro 0~2.62%)，为变质成因。堆晶岩包括纯橄岩、异剥橄榄岩、(石榴石)辉石岩和辉长岩。堆晶纯橄岩与层状杂岩伴生，偶含少量斜长石。异剥橄榄岩由橄榄石、透辉石和少量斜长石组成。层状辉长岩-辉石岩杂岩由透辉石和斜长石组成，两种矿物交替形成层状堆积层理。石榴石辉石岩或异剥钙榴岩呈团块状产于变质橄榄岩中，其中的石榴石为钙铝榴石 (Gro 69.19%~89.93%；And 9.12%~18.84%；Br 0.73%~11.63%)，也属变质成因。辉绿岩墙显示LREE亏损，(La/Sm)N = 0.5~0.8，HREE呈近平坦型分布，Eu正异常 ( $\delta Eu$  1.2~1.6)。玄武岩的REE模式与MORB类似，(La/Sm)N = 0.5~0.9，显示不同程度的Eu负异常。熔岩的成分尤其一致的REE模式说明结晶过程中未发生明显的分异作用以及外来成分的混染。熔岩中的锆石SHRIMP U-Pb测年获得<sup>206</sup>Pb/<sup>238</sup>U年龄为(276~319) Ma，平均(308.2±4.9) Ma，认为代表蛇绿岩洋壳形成时代。强烈的蛇纹石化和碳酸岩化反映了海底热液蚀变作用并伴随德尔尼块状硫化物矿床的形成。德尔尼蛇绿岩是一个被构造肢解的古洋壳，可能形成于一个快速扩张的洋脊，在古特提斯洋盆关闭时侵位，标志来自冈瓦纳大陆的陆块与原欧亚大陆的缝合带。

关键词：蛇绿岩； 德尔尼； 阿尼玛卿； 东昆仑； 西藏

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The Dur'ngoi ophiolite in East Kunlun, northern Qinghai-Tibet Plateau:  
a fragment of paleo-Tethyan oceanic crust

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Abstract: The Dur'ngoi ophiolite in the north Qinghai-Tibetan Plateau consists of meta-peridotite, mafic-ultramafic cumulate, sheeted dikes and basaltic lavas. The meta-peridotite consists of dunite, harzburgite, lherzolite, feldspar-bearing lherzolite and garnet-bearing lherzolite and contains residual spinel with Cr#s [ $100 \times Cr/(Cr+Al)$ ] of 30-57 and Mg#s [ $100 \times Mg/(Mg+Fe^{2+})$ ] of 50-75, indicating an Al- and Mg-rich series. The meta-peridotites have a relatively narrow range of composition with Mg#s of 89.2-92.6, Al<sub>2</sub>O<sub>3</sub> contents of 1%-4 % and slightly depleted REE patterns, indicating that they represent relict mantle material that has undergone intermediate to low degrees of partial melting. Garnets in the lherzolite are andradite enriched in Ca and Fe and depleted in Mg and Al (And 95-97, Pyr 0.27-5.06, Gro 0-2.62), indicating that they formed by metamorphism. Cumulates consist mainly of dunite, wehrlite, pyroxenite and gabbro. The dunite contains minor feldspar, mostly replaced by chlorite and clay minerals. The wehrlite consists of olivine, diopside and minor plagioclase. A well-layered gabbro-pyroxenite complex is defined by variations in modal plagioclase and pyroxene. Blocks of garnet-pyroxenite or rodingite are locally present in the meta-peridotite. Garnets in the cumulates are grossular (Gro 69.19-89.93; And 9.12-18.84; Br 0.73-11.63), formed by metamorphism. Diabase dikes are depleted in LREE with (La/Sm)N ratios of 0.49-0.75 and have flat HREE patterns with positive Eu anomalies ( $\delta Eu = 1.14-1.27$ ). Basalts have REE patterns similar to those of MORB with (La/Sm)N ratios of 0.46-0.95 and small negative Eu anomalies. The basalt compositions, particularly their consistent REE patterns, suggest no contamination in their magma source and little differentiation during crystallization. SHRIMP U-Pb dating of zircons from the basalts yielded <sup>206</sup>Pb/<sup>238</sup>U ages of 276-319 Ma (average 308.2±4.9 Ma). The Dur'ngoi ophiolite is interpreted as a dismembered fragment of paleo-oceanic crust formed at a fast-spreading mid-ocean ridge. Intense serpentinization and carbonization reflect hydrothermal alteration on the seafloor associated with formation of the Dur'ngoi Cu-Co-Zn massive sulfide deposit. The ophiolite was probably emplaced during closure of the paleo-Tethyan ocean basin and is believed to mark the suture between

Gondwana and Eurasia.

Key words: Ophiolite; Dur'ngoi; A'nyemaqen; East Kunlun; Tibetan