

doi: 10.12029/gc20160508

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南岭科学钻探青白口系中发现 381 Ma 流纹岩

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摘要:南岭科学钻探(NLSD-1)选址于江西省于都—兴国—宁都三县交界地区实施,构造上属华夏板块内部的武夷和罗霄两块体交汇部位。南岭科学钻探瞄准构造结合部区域地质问题和矿集区深部成矿预测两方面科学目标进行探索。NLSD-1 开孔至 1373.71 m 揭露了连续的青白口纪地层,是一套完整的凝灰质火山碎屑岩韵律层,主要岩性有凝灰质粉砂岩、凝灰质细砂岩、变沉凝灰岩、凝灰质板岩和流纹岩。本次工作在科学钻探精细地质编录的基础上,对各类岩性地层进行镜下鉴定,并挑选流纹岩中的单颗粒锆石,应用 LA-ICP-MS 锆石 U-Pb 法进行定年,获得了一组高度谐和的同位素年龄,确定流纹岩成岩时代为 381 Ma,为赣中南地区新元古代地层时代的进一步划分、归属和地质演化研究提供了新的信息。

关键词:南岭地区;科学钻探;青白口系;流纹岩;锆石 U-Pb 法

中图分类号:P534.3;P634.1

文献标志码:A

文章编号:1000-3657(2016)05-1579-06

381 Ma rhyolite found by Nanling scientific drilling in Qingbaikouan System

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Abstract: Nanling scientific drilling (NLSD-1) is located at the junction of Yudu-Ningdu-Xingguo county in Jiangxi Province. Tectonically, the hole site of NLSD-1 is located at the intersection of Wuyi and Luoxiao block inside the Cathaysian plate. NLSD-1 aims at solving the scientific problems of regional geology and metallogenic regularity in the ore concentration area. The NLSD-1 hole intersects Qingbaikouan strata at 1373.71 m which are composed of a rhythm layer of tuffaceous volcanic clastic rock consisting of tuffaceous siltstone, tuffaceous sandstone, variable tuff, tuffaceous slate and rhyolite. Based on detailed geological logging and identification of different kinds of lithostratigraphy under microscope, the authors selected zircons from the rhyolite of

收稿日期:2016-05-19; 改回日期:2016-08-18

基金项目:国土资源部公益性行业科研专项(201311162, 201411050)、国家自然科学基金项目(41372092)、国家重点研发计划课题(2016YFC0600208)、中国地质大调查项目之整装勘查区找矿预测研究项目(12120114034801)联合资助。

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NLSD-1. A set of high harmonic isotopic ages were obtained by using LA-ICP-MS, which can be used to make sure that the formation age of rhyolite is 381 Ma. This datum provides new information for the further division, assignment and study of geological evolution of stratigraphic age of Late Proterozoic in the middle south area of Jiangxi Province.

Key words: Nanling; scientific drilling; Qingbaikouan System; rhyolite; zircon Pb-U method

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Fund support: Supported by the Public Welfare Industry Scientific Research Projects of Ministry of Land and Resources (No. 201311162, 201411050), National Natural Science Foundation of China (No. 41372092), National Key Basic Research Program of China (No. 2016YFC0600208), China Geological Survey Program (No. 12120114034801).

华南地区自元古宙到中生代历经了多期构造演化、岩浆活动和成矿作用,其鲜明的地质格局、独特的地壳生长和广泛分布的多金属矿产世界罕见,反映了其复杂的地球动力学背景和构造演化历史^[1-6]。南岭科学钻探(NLSD-1)选址于江西省于都县银坑地区,大地构造上位于武夷和罗霄地块交汇复合部位(图1),旨在探索重要成矿区带深部成矿规律和深部地质构造等科学目标^[7]。南岭科学钻探揭露了0~

1373.71 m的青白口系,为本区前寒武系基底的研究提供了重要的实物地质资料,本文在科学钻探精细地质编录的基础上,应用LA-ICP-MS 锆石 U-Pb 法,精确厘定了青白口纪地层中揭露的流纹岩的成岩时代,并以此展开讨论。

1 区域地质

南岭科学钻探(NLSD-1)开孔于江西银坑—青

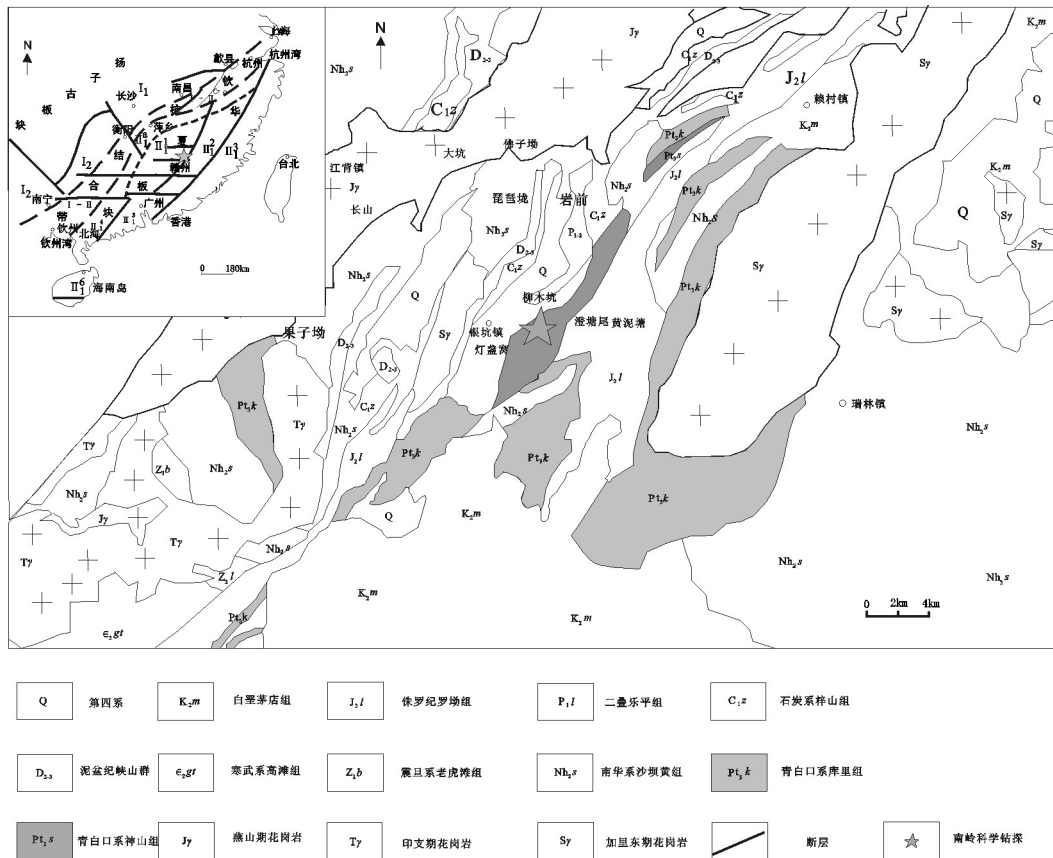


图1 南岭科学钻探位置及赣南银坑地区地质略图
Fig.1 Position of Nanling scientific drilling and geological sketch of Yinkeng in Gannan

塘盆地内,大地构造位置属华夏地块之罗霄褶皱带与武夷褶皱带的结合部。区域构造上表现为东西向、近南北向、北西向和北东向构造交织。岩浆活动上以发育加里东期和燕山期酸性侵入体为主。区内以广泛出露新元古代褶皱基底为特色,晚古生代盖层褶皱和沿中生代构造盆地分布的红层沉积于其上(图1)。

NLSD-1共获得2968.12 m连续的岩心样品,揭露了丰富而连续的地层、构造、岩浆岩和矿化信息^[8-9]。地层主要为两套,上部0~1373.71 m的青白口系由变质沉积凝灰岩、变质沉积凝灰质砂岩、凝灰质板岩互层组成,间夹4段流纹岩;其下部为二叠系乐平组炭质

板岩和车头组—栖霞组泥灰岩(图2-A)。

2 样品采集和测试

用于挑选锆石定年的流纹岩产自NLSD-1孔深80~85 m处岩心。样品经人工破碎、重力磁选、在双目镜下挑选出晶形完整的锆石,置于环氧树脂制靶。将靶上锆石研磨至一半,使其内部暴露,用于阴极发光和背散射图像鉴定。

锆石的阴极发光和背散射电子图像分析使用中国地质科学院矿产资源研究所的日产电子探针JOELJXA8800R完成;锆石的U-Pb测年使用矿产资源研究所的LA-MC-ICPMS完成,激光剥蚀系

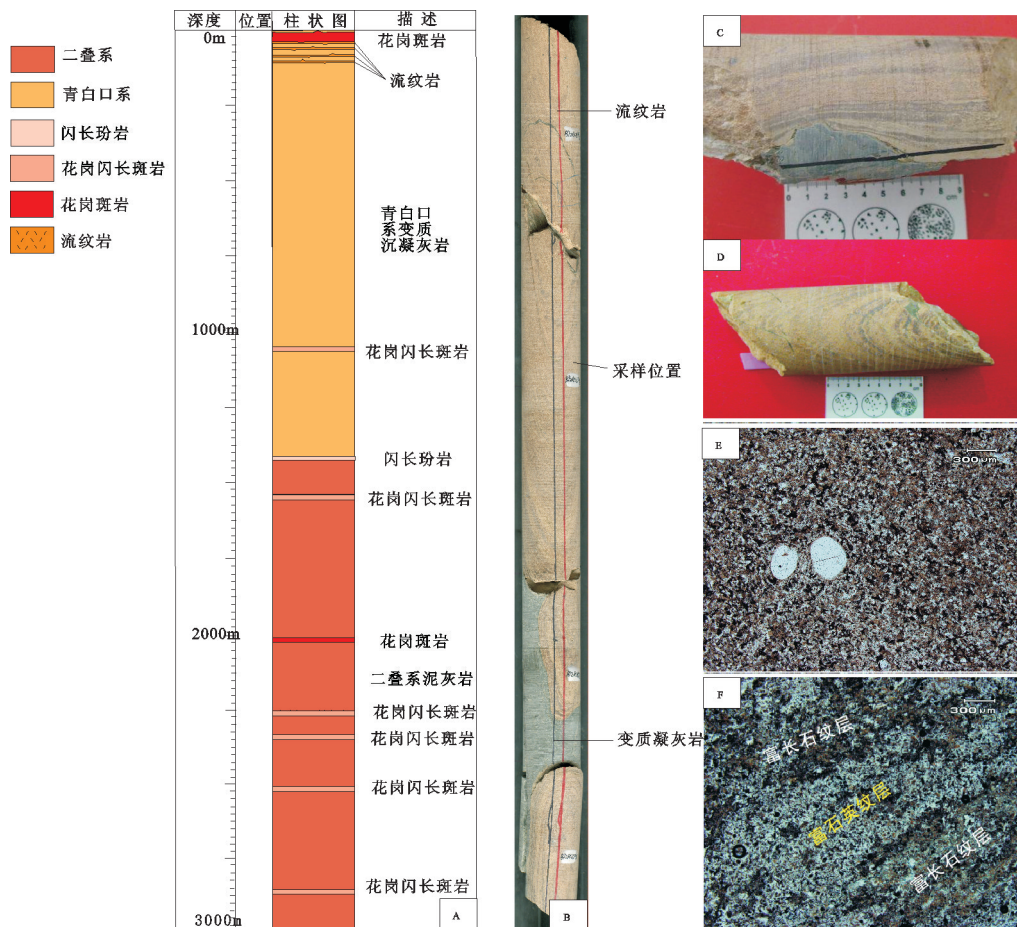


图2 南岭科学钻探中的流纹岩
A—南岭科学钻探0~3000 m岩心柱状图;B—南岭科学钻探80~85 m岩心扫描图;C—流纹岩与凝灰岩整合接触;
D—流纹岩;E、F—流纹岩显微结构照片

Fig.2 Liparite in Nanling scientific drilling

A—0~3000 m core column in Nanling scientific drilling;B—80~85 m core scan map in Nanling scientific drilling;C—Conformable contact with rhyolite and tuff;D—Rhyolite;E, F—Pictures of the microstructures of rhyolite

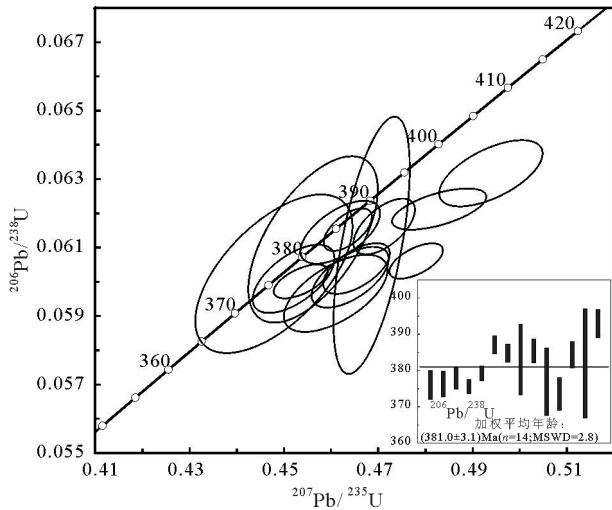


图3 NLSD-1 流纹岩锆石的U-Pb年龄谐和图
Fig.3 Zircon U-Pb concordia diagram

统为NewWave UP 213,分析时采用的激光斑束直径为25 μm,剥蚀频率为10 Hz,每10个样品点夹2个参考标准GJ-1和1个Plesovice标准分析,数据处理采用ICPMSDataCal软件^[10]。

3 测试结果

共测定了流纹岩中20个颗粒锆石,其中14个分析点数据高度谐和,²⁰⁶Pb/²³⁸U年龄集中在373.6~393.0 Ma,加权平均值为(381.0±3.1) Ma (MSWD=2.8, n=14),代表了岩浆的结晶时间。1、3号分析点

锆石²⁰⁶Pb/²³⁸U年龄为547.9~548.8 Ma;2、7、11、13号分析点锆石²⁰⁶Pb/²³⁸U年龄为700.2~726.8 Ma,结合锆石晶形判断此两组为捕获晶锆石和继承锆石。

4 讨论与结论

青白口系是华南地区的基底岩系,在赣中南地区以库里组(Pt₃k)出露面积最大(银坑盆地内约200 km²),沉积厚度大于1000 m,主要岩性有变沉凝灰岩、凝灰质粉砂岩、凝灰质板岩夹流纹岩和细碧角斑岩、局部千枚岩化,为一套海相火山-沉积建造,与下伏神山组、上覆上施组呈整合接触。神山组零星出露,下未见底,由深灰、浅灰色薄层状变质粉砂岩、变质千枚状粉砂岩、千枚岩,夹黑色含炭千枚岩组成不等厚韵律互层,属含炭细碎屑岩建造^[11-13](图1)。

本文将南岭科学钻探剖面与区域地质测量(1:20万兴国幅^[14]和1:5万银坑幅^[15])成果对比,确定NLSD-1岩心0~1373.71 m揭露地层为青白口系,即华南南区青白口纪晚期海相火山碎屑岩夹酸性火山熔岩沉积序列;通过库里组层序对比、接触关系和岩相学研究,确定NLSD-1揭露之流纹岩为该套变沉凝灰岩夹流纹岩地层序列的组成。流纹岩镜下特征中长石纹层和石英纹层清晰,表现为明显的流纹结构;所挑选出单颗粒锆石震荡环带等特征清晰,表明实验所选锆石为原生岩浆锆石;实验室LA-MC-ICPMS测试流程成熟、仪器稳定,标样测

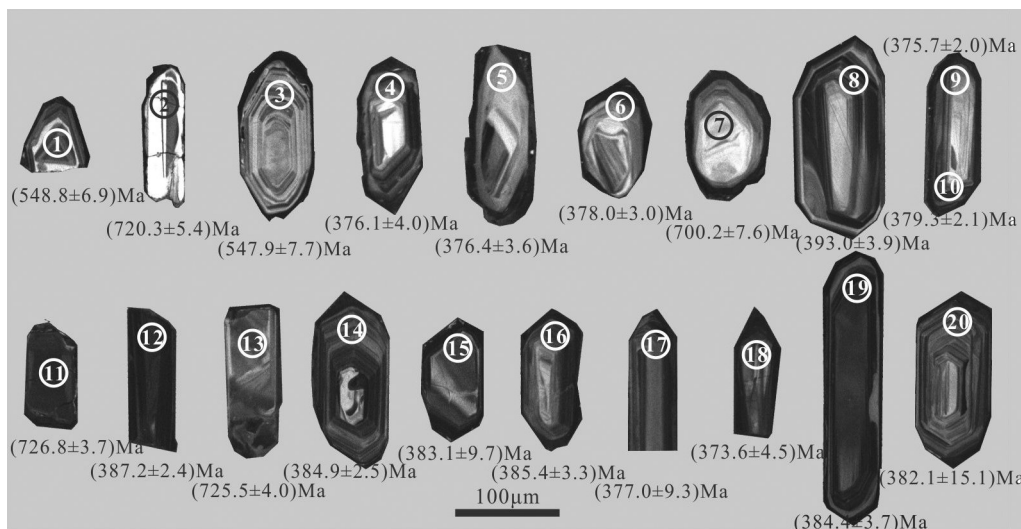


图4 典型的锆石阴极发光图和U-Pb测点数据
Fig.4 Typical zircon CL images,analyzed spot and ²⁰⁶Pb/²³⁸U age

表1 流纹斑岩锆石 LA-MC-ICP-MS 分析数据
Table 1 LA-MC-ICP-MS zircon analytical data for rhyolite porphyry from NLS-D-1

点号	含量/ 10^{-6}			同位素比值						表面年龄/Ma		
	Pb	Th	U	Th/U	$^{207}\text{Pb}/^{206}\text{Pb}$	$\pm 1\sigma$	$^{207}\text{Pb}/^{235}\text{U}$	$\pm 1\sigma$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm 1\sigma$	$^{206}\text{Pb}/^{238}\text{U}$	$\pm 1\sigma$
4	68	57	199	0.29	0.0543	0.0003	0.452	0.0057	0.0601	0.0007	376	4.0
5	131	114	123	0.93	0.0558	0.0005	0.464	0.0054	0.0601	0.0006	376	3.6
6	124	106	138	0.77	0.0556	0.0003	0.465	0.0047	0.0604	0.0005	378	3.0
8	178	94	342	0.28	0.0577	0.0009	0.500	0.0072	0.0629	0.0006	393	3.9
9	159	177	90	1.96	0.0547	0.0004	0.454	0.0038	0.0600	0.0003	375	2.0
10	226	270	125	2.15	0.0572	0.0004	0.478	0.0037	0.0606	0.0003	379	2.1
12	169	103	990	0.10	0.0571	0.0006	0.487	0.0066	0.0619	0.0004	387	2.4
14	119	115	644	0.18	0.0546	0.0002	0.464	0.0034	0.0615	0.0004	385	2.5
15	67	56	566	0.10	0.0541	0.0008	0.456	0.0091	0.0612	0.0016	383	9.7
16	113	111	247	0.45	0.0555	0.0003	0.471	0.0043	0.0616	0.0005	385	3.3
17	98	86	344	0.25	0.0540	0.0005	0.448	0.0110	0.0602	0.0015	377	9.3
18	298	248	364	0.68	0.0560	0.0005	0.461	0.0072	0.0597	0.0007	373	4.5
19	143	104	833	0.13	0.0545	0.0003	0.462	0.0056	0.0614	0.0006	384	3.7
20	163	99	361	0.28	0.0557	0.0017	0.469	0.0053	0.0611	0.0025	382	15.1

试结果准确控制在误差范围之内,确定本组锆石 U-Pb 谐和年龄数据可以代表该套流纹岩的形成时代。

区域上大量的岩浆岩研究成果表明^[16-17],该区晋宁期之后的岩浆活动集中在晚加里东期、印支期和燕山期,且均为花岗质中酸-酸性侵入岩,研究区银坑-青塘盆地东侧之鹅婆岩体(加里东期)^[18]、西侧之江背岩体(燕山早期)和盆地内各类岩浆岩脉^[19]之时序均未发现该区存在海西期岩浆活动。因而,在率先确定流纹岩与青白口系归属关系基础上,南岭科学钻探中 381 Ma 流纹岩的发现,为华南地区青白口系晚期地层的划分提供了新的年代学信息,为华夏陆块的地质构造演化研究提供新的线索。华南地区由多陆块拼合、经历了复杂的构造演化过程^[20],对该套地层的时代归属是否可以重新厘定?或者是否存在构造混杂带基底?尚需对华南各区前寒武系基底开展进一步的地层学和年代学的综合对比研究。

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