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辽北清原杂岩锆石年代学与地球化学测试数据集

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摘要：辽北清原杂岩锆石年代学与地球化学测试数据库（集）基于亚洲系列地质图件编制及相关重大地质问题研究项目“亚洲晚太古代地层全球性对比”资助，进行岩石测试分析整理而得。锆石年代学数据可以准确地反映原岩的形成时代与形成后所经历的构造岩浆事件，岩石地球化学数据可以反映岩石本身的化学特征，二者相结合可以为研究辽北地区地壳演化历史提供科学依据与基础数据支持。本文采集了辽北地区清原杂岩中高级变质表壳岩与英云闪长质—奥长花岗质—花岗闪长质（TTG）片麻岩单元中的岩石样品，岩石类型包括片麻状花岗闪长岩、云英闪长质片麻岩、奥长花岗质片麻岩、花岗闪长质混合片麻岩、透辉角闪变粒岩、角闪黑云斜长片麻岩、片麻状紫苏花岗岩、石榴紫苏黑云斜长片麻岩、花岗质片麻岩、角闪透辉黑云斜长片麻岩、变质中性火山岩、黑云斜长片麻岩、斜长角闪岩以及矽线石榴片麻岩等。本数据集为 Excel 表格型数据，包括 2 个 .xls 类型文件（Zircon_U–Pb dating data_QY.xls, Geochemistry data_QY.xls）分别记录了样品的锆石 U–Pb 测年数据与地球化学数据。本数据集样品测试工作均在国家地质实验测试中心完成，数据质量可靠。

关键词：太古宙；华北克拉通；清原杂岩；锆石年代学数据；岩石地球化学数据
数据服务系统网址：http://dcc.cgs.gov.cn

1　引言

华北克拉通是世界上最古老的克拉通之一（Liu et al., 1992，2008；万渝生等，2009），目前的研究者们普遍认为华北克拉通变质基底是由多个微陆块经过拼贴碰撞而成。但对于微陆块的数量、碰撞拼贴方式与时限仍然存在较大的争议。伍家善等（1998）认为华北地台太古宙陆壳可以划分为胶辽、迁怀、晋冀、豫皖与蒙陕等五个地块，胶辽与迁怀地块在 2.5 Ga 拼贴，后与其它三个地块相继碰撞拼贴，在 1.8 Ga 最终克拉通化。以陆核增生理论为依据，Zhai et al.（2000）提出华北克拉通是由胶辽、迁怀、许昌、阜平、集宁和阿拉善等 6 个古陆核组成，这些微陆块在太古宙末期（~ 2.5 Ga）就已经通过弧陆碰撞拼合克拉通化。部分学者提出华北克拉通是由东部陆块和西部陆块在 1.85 Ga

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沿中部碰撞带最终拼合而成，其中东部陆块经历了 1.9 ~ 2.1 Ga 的胶—辽—吉裂谷作用，西部陆块则由阴山地块与鄂尔多斯地块在 ~ 1.92 Ga 沿着 Khondalite 带碰撞拼贴而成（图 1）（Zhao et al., 1999，2005 ；Liu et al., 2002 ；Guo et al., 2012）。最后一种划分方案为大多数学者所接受。

辽北—吉南变质地体位于华北克拉通东北缘，是华北克拉通主要出露区之一（图 1），沈保丰等（1994）将本区划分为分布于龙岗山和浑南地区的高角闪岩相—麻粒岩相高级变质区和分布于清原、板石沟、夹皮沟和金城洞地区的绿帘角闪岩相—低角闪岩相的花岗岩—绿岩带。辽北—吉南变质地体西部与广泛发育新太古代变质表壳岩（2.62 ~ 2.50 Ga）和古老深成侵入体（2.55 ~ 2.50 Ga）的河北承德—阜新变质地体相连（Geng et al., 2006 ；Wang et al., 2011 ；Guo et al., 2013），东部与记录大量古元古代（2.1 ~ 1.9 Ga）锆石信息的胶—辽—吉构造带相接（Li et al., 2012），南部与具有华北克拉通最古岩石（~ 3.8 Ga）的鞍山—本溪变质地体相连（Liu et al., 1992）。因此辽北—吉南变质地体是连接华北克拉通太古代不同微陆块的重要单元，对了解不同变质地体之间的地质关系具有重要的意义（白翔等，2014）。

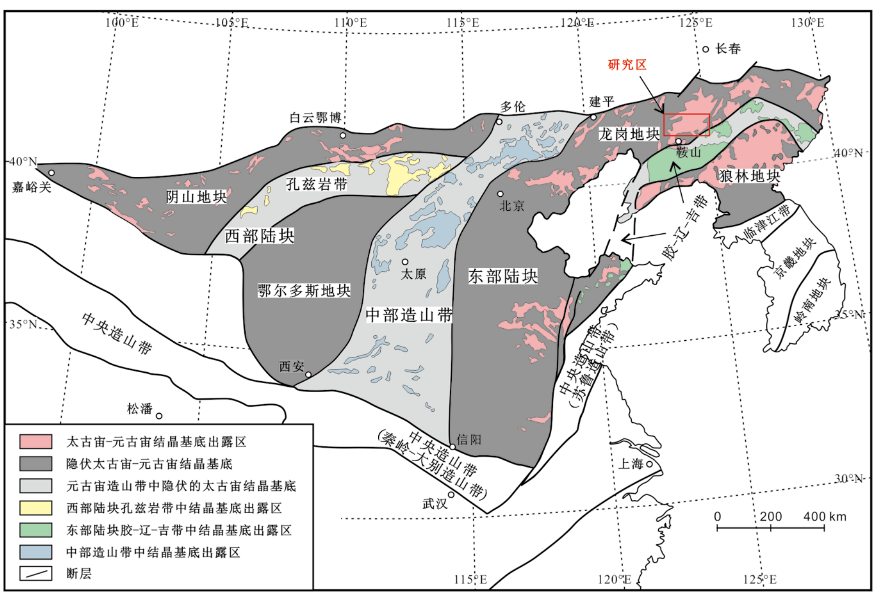

图 1　华北克拉通基底构造单元划分及研究区位置（据 Zhao et al., 2005）

清原杂岩是辽北—吉南变质地体的重要组成部分，主要由 TTG 片麻岩、紫苏花岗岩与高角闪岩相到麻粒岩相表壳岩构成（沈保丰等，1994）。本文的测试样品主要采集于这些岩石当中（图 2）。TTG 片麻岩占清原杂岩总体积的 50% 以上，主要分布在清原红透山、何家堡子、十八道岭和树基沟一带。岩石内部含有特征性的指示矿物石榴石，在整个清原地区具有区域对比意义（张雅静等，2014）。紫苏花岗岩通常与麻粒岩相表壳岩伴生，在清原地区出露面积不大，最大几百平方米，小者露头仅十几平方米。主要分布于线金厂、五构头、景家沟、中心屯一带，中心屯紫苏花岗杂岩体中，常见麻粒岩相表壳岩包体（张秋生，1984）。表壳岩主要为一套由镁铁质到长英质火山岩与碎屑沉积岩构成的岩石建造，由下至上可分为景家沟岩组（在浑南地区对应小莱河岩组）、石棚子岩组、金凤岭岩组、红透山岩组与南天门岩组（于凤金等，2006）。伴随着后期构

造岩浆事件的改造，清原杂岩内部出现了一系列对国民经济起到至关重要作用的金属矿床，包括与火山岩有关的块状硫化物矿床（红透山铜锌金矿、树基沟铜锌金矿）、条带铁建造（BIF）（小莱河铁矿）、变质热液脉型金矿（南龙王庙金矿、下大堡金矿）。因此对清原杂岩的研究不仅有助于揭示华北克拉通的地质演化历史，还可以为寻找重要的金属矿床起到指导性的作用，而对清原杂岩锆石年代学与地球化学数据的采集是进行这些研究的基础。

辽北清原杂岩锆石年代学与地球化学测试数据库元数据简介见表 1。

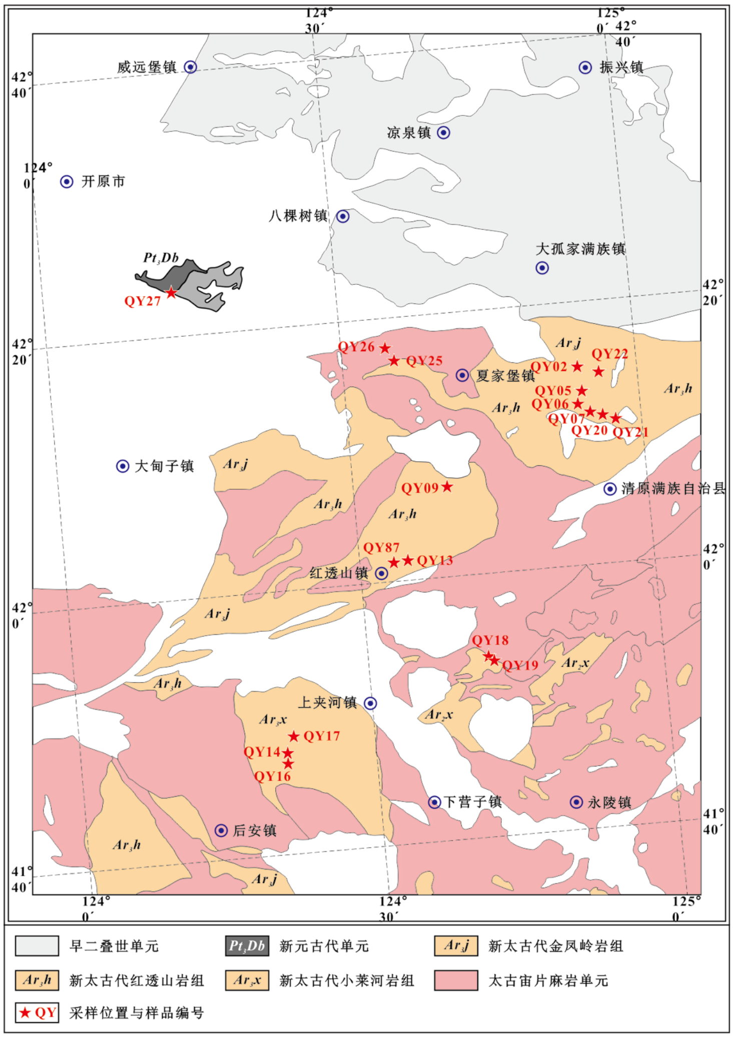

图 2　辽北地区太古宙地质图及采样位置（据 1∶50 万数字地质图修改简化）

2　数据采集和处理方法

2.1　样品采集

本次地质研究所采集的岩石样品来自辽北地区清原杂岩中的高级变质表壳岩与 TTG 片麻岩单元，共 26 件，其中 12 件样品进行了锆石 U-Pb 测年分析，23 件样品进行了锆石 U-Pb 测年与地球化学分析。表壳岩的地层包括清原群小莱河岩组、金凤岭岩组与红透山岩组。岩石类型包括片麻状花岗闪长岩、云英闪长质片麻岩、奥长花岗质片麻岩、

花岗闪长质混合片麻岩、透辉角闪变粒岩、角闪黑云斜长片麻岩、片麻状紫苏花岗岩、石榴紫苏黑云斜长片麻岩、花岗质片麻岩、角闪透辉黑云斜长片麻岩、变质中性火山岩、黑云斜长片麻岩、斜长角闪岩以及矽线石榴片麻岩等。岩石的采样地点与具体的矿物组合见表 2，矿物简称采用 Whitney et al. (2010) 的方案。

表 1　数据库（集）元数据简表

条目	描述
数据库（集）名称	辽北清原杂岩地球化学与锆石年代学测试数据集
数据库（集）作者	李崇，中国地质科学院地质研究所 任留东，中国地质科学院地质研究所
数据时间范围	2011—2013 年
地理区域	辽北清原地区
数据格式	*.xls
数据量	344 KB
数据服务系统网址	http://dcc.cgs.gov.cn
基金项目	中国地质调查局地质调查项目（1212011120129）
语种	中文
数据库（集）组成	数据集由 2 部分数据组成 :（1）Zircon_U-Pb dating data_QY.xls，为锆石 U-Pb 测年数据，包括 12 件样品，每个样品为一个单独的工作表（sheet），每个工作表（sheet）包含样品编号、采样点、岩石类型、分析点号、同位素比值、年龄、误差等数据 ;（2）Geochemistry data_QY.xls，为岩石地球化学数据，包括 23 件样品以及样品编号与岩石类型

表 2　辽北清原杂岩样品产地及矿物组合

样品号	地点（辽北）	岩石类型（特征矿物）	锆石年龄（Ma）
QY02-1	清原中心屯村	片麻状花岗闪长岩（hbl, bt, pl, kfs, qtz, ep）	
QY05-1	清原四合永屯	片麻状紫苏花岗岩（bt, hbl, kfs, pl, qtz, opx, ap, mgt）	2528±33 (I); 2506±16(M); 2499±16(R)
QY06-1	清原金泉线	云英闪长质片麻岩（hbl, pl, qtz, bt, kfs）	
QY07-1	清原枸乃甸子	云英闪长质片麻岩（hbl, pl, qtz, bt, kfs）	
QY09-12	清原树基沟	奥长花岗质片麻岩（kfs, qtz, bt, pl, bt）	
QY13-1	清原十八道岭北	花岗闪长质混合片麻岩（pl, qtz, ap, ep, chl, cal）	2566±12 (M); 2534±27(R)
QY14-1	清原石棚子村	花岗闪长质片麻岩（hbl, bt, pl, kfs, qtz, ep）	
QY14-3	清原石棚子村	片麻状花岗闪长岩（hbl, bt, pl, kfs, qtz, ep）	
QY16-1(2)	清原石棚子村	云英闪长质片麻岩（hbl, pl, qtz, bt, kfs）	
QY16-8	清原石棚子村	片麻状花岗闪长岩（hbl, bt, pl, kfs, qtz, ep）	
QY17-1	清原石棚子村北	透辉角闪变粒岩（hbl, pl, cpx, ap, mgt, qz）	2527±15 (I); 2511±18(M); 2501±31(R)
QY18-5	清原小莱河铁矿	奥长花岗质片麻岩（kfs, qtz, bt, pl, bt）	
QY18-7	清原小莱河铁矿	花岗闪长质片麻岩（pl, qtz, ap, ep, chl, cal）	
QY18-8	清原小莱河铁矿	云英闪长质片麻岩（hbl, pl, qtz, bt, kfs	

续表 2

样品号	地点（辽北）	岩石类型（特征矿物）	锆石年龄（Ma）
QY19-1	清原小莱河铁矿坑	角闪黑云斜长片麻岩（bt, pl, hbl, kfs, qz, ap, cal, chl）	2525±25 (I); 2497±15(M); 2505±38(R
QY20-1	清原构乃甸子南	花岗质片麻岩（opx, cal, bt, qz, kfs, pl, amp, sph）	2495±21 (M); 2455±30(R)
QY20-2	清原构乃甸子南	角闪透辉黑云斜长片麻岩（bt, cpx, hbl, pl, kfs, qz, ep, amp, ap）	2492±22 (M); 2467±23(R)
QY21-1	清原构乃甸南	石榴紫苏黑云斜长片麻岩（bt, grt, pl, opx, qz）	2528±22 (I); 2494±33(M); 2479±21(R)
QY22-7	清原县线金场东北	片麻状花岗闪长岩（hbl, bt, pl, kfs, qtz, ep）	
QY25-1	清原小孤家南	角闪黑云斜长片麻岩（TTG）（bt, pl, hbl, ep, cal	2492±21(M); 2467±13(R)
QY26-1	清原北葳子南	片麻状花岗岩（pl, kfs, qtz, bt, hbl）	
QY26-2	清原北葳子南	片麻状花岗岩（pl, kfs, qtz, bt, hbl）	
QY27-1	开原妈妈货郎	变质中性火山岩（pl, bt, ep, chl, kfs, amp）	2504±25 (M); 2468±15(R)
QY87-1	红透山矿区后山梁	矽线石榴片麻岩（sil, grt, ky, st, ged, opx, bt, qz, pl）	2509±8 (M); 2497±7(R)
QY87-2	红透山矿区后山梁	斜长角闪岩（pl, ged, qtz	2538±12 (M); 2528±17(R)
QY87-8	红透山矿区后山梁	黑云斜长片麻岩（bt, grt, opx, rt, qtz, pl）	2560±12 (M); 2528±18(R)

锆石年龄栏内：I= 继承锆石核年龄；M= 岩浆锆石年龄；R：锆石变质边重启年龄

2.2 测试方法

本次研究工作对辽北地区清原杂岩中的高级变质表壳岩与 TTG 片麻单元中的岩石样品进行了锆石测年与地球化学分析。样品锆石的分选在河北省廊坊市诚信地质服务有限公司实验室进行，在对样品破碎、清洗、烘干和筛选后，采用磁选和重液分离技术将锆石选出，然后在双目镜下挑选颗粒大、形态完整的锆石。锆石的阴极发光图像和背散射图像在中国地质科学院矿产资源研究所 LA–ICP–MS FEI PHILIPS XL30 SFEG 电镜上进行。在测试前先结合锆石阴极发光图像、透射光、背散射图像，标定合适的锆石颗粒以备年龄测定。锆石 U–Pb LA–ICP–MS 定年测试在国家地质实验测试中心 Thermo Element II 质谱仪上进行。采用 He 作为剥蚀物质的载气，用美国国家标准技术研究院研制的人工合成硅酸盐玻璃标准参考物质 NIST610 进行仪器最优化，锆石年龄采用标准锆石 GJ–1 和 Plesovice 作为外标准物质进行校正，每隔 5 个样品，加测两个标样各一次。原始数据采用 GLITTER 软件处理，锆石年龄谐和图应用 ISOPLOT 3.0 程序完成（Ludwig, 2003）；全岩地球化学测试分析工作于国家地质实验测试中心完成，上述样品常量元素含量测试采用 X– 射线荧光光谱法（XRF），稀土微量元素测试采用 ICPMS 法。其中，全岩主量元素分析误差优于 5%；微量元素测定时，当元素含量大于 10×10^{-6} 时，误差小于 10%。

3 数据样本描述

辽北清原杂岩锆石年代学与地球化学测试数据集为 Excel 表格型数据，包括 2 个

Excel 数据文件，分别为“Zircon_U−Pb dating data_QY.xls”与“Geochemistry data_QY.xls”。其中，“Zircon_U−Pb dating data_QY.xls”数据文件，描述研究区内样品 U−Pb 年龄信息，包括 12 件锆石测年样品，每个样品为一个单独的工作表（sheet），每个工作表（sheet）包含样品编号、采样点、岩石类型、分析点号、Th/U 比值、同位素比值、年龄、误差等数据（表 3）；“Geochemistry data_QY.xls”数据文件，包括 23 件测试样品以及样品编号、岩石类型与岩石地球化学信息（表 4）。

表 3　锆石 U−Pb 同位素测年数据表

样品编号	字符型									
采样点	字符型									
岩石类型	字符型									
LA−ICP−MS 锆石分析数据与年龄值										
分析点	同位素比值				表观年龄（Ma）					
	$^{207}Pb/^{235}U$	±1σ	$^{206}Pb/^{238}U$	±1σ	$^{206}Pb/^{238}U$	±1σ	$^{207}Pb/^{236}U$	±1σ	$^{207}Pb/^{238}U$	±1σ
字符型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型
字符型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型
实例										
样品编号	QY05-1									
采样点	辽宁清原四合永屯									
岩石类型	片麻状紫苏花岗岩									
LA−ICP−MS 锆石分析数据与年龄值										
分析点	同位素比值				表观年龄（Ma）					
	$^{207}Pb/^{235}U$	±1σ	$^{206}Pb/^{238}U$	±1σ	$^{206}Pb/^{238}U$	±1σ	$^{207}Pb/^{236}U$	±1σ	$^{207}Pb/^{238}U$	±1σ
QY05-1_1	11.13	0.23	0.48	0.01	2502	33	2534	19	2533	38
QY05-1_2	10.66	0.22	0.47	0.01	2442	33	2494	19	2493	38

表 4　岩石地球化学数据表

岩石类型	字符型	字符型	字符型	字符型	字符型	字符型	字符型	字符型	字符型
样品编号	字符型	字符型	字符型	字符型	字符型	字符型	字符型	字符型	字符型
元素	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型	浮点型
实例									
岩石类型	片麻状紫苏花岗岩	花岗闪长质混合岩	透辉角闪变粒岩	角闪黑云斜长片麻岩	花岗质片麻岩	角闪透辉黑云斜长片麻岩	石榴紫苏黑云斜长片麻岩	角闪黑云斜长片麻岩	变质中性火山岩
样品编号	QY05−1	QY13−1	QY17−1	QY19−1	QY20−1	QY20−2	QY21−1	QY25−1	QY27−1
SiO_2 / %	68.05	64.60	56.89	63.50	70.23	58.20	61.14	60.37	59.76

4　数据质量控制和评估

样品锆石年代学与地球化学测试均在国家地质实验测试中心完成。测试方法与过程均严格遵守国标进行。由于辽北清原杂岩经历了复杂的构造演化历史，锆石常常具有

多期生长域，因此在进行锆石测年实验之前，我们对锆石靶进行透射光与阴极发光照片的拍摄，目的是为了选取合适的颗粒与标注测定点的位置，避免测试点位于不同锆石生长域的边界或者位于锆石的裂隙，从而得出无意义的锆石年龄。LA–ICP–MS 锆石 U–Pb 测年实验的过程与侯可军等（2007）方法基本一致，分别选取 GJ–1 锆石（澳大利亚 MacQuarie 大学大陆地球化学与成矿作用研究中心实验室标准样品）与 Plesovice 锆石（挪威卑尔根大学地球科学系实验室 U–Pb 测得标准）进行外标校正，所测 U–Pb 数据点基本位于谐和线上。所测得的锆石年龄结果可以在区域上与其他学者的数据结果进行对比（万渝生等，2005 ；Grant et al., 2009 ；白翔等，2014）。

5 结论

辽北清原杂岩锆石年代学与地球化学测试数据集为 Excel 表格型数据，包括 2 个 Excel 数据文件，分别为“ Zircon_U–Pb dating data_QY.xls ”与“ Geochemistry data_QY.xls ”。其中，“ Zircon_U–Pb dating data_QY.xls ”数据文件，描述研究区内样品 U–Pb 年龄信息，包括 12 件测年样品，每个样品为一个单独的工作表（sheet），每个工作表（sheet）包含样品编号、采样点、岩石类型、分析点号、Th/U 比值、同位素比值、年龄、误差等数据；“ Geochemistry data_QY.xls ”数据文件，包括 23 件测试样品以及样品编号、岩石类型与岩石地球化学信息。辽北清原杂岩锆石年代学与地球化学测试数据集可以为研究华北克拉通的地质演化历史与辽北地区找矿提供关键性的基础数据。

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The Dataset of Zircon Geochronological & Geochemical Testing of Qingyuan Complex in Northern Liaoning Province

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Abstract: The dataset of zircon geochronological testing of the Qingyuan Complex in Northern Liaoning Province gets its information from the rock testing and analysis activities under the financial support of the project'Global Correlation of Asian's Neoarchean Strata', which is actually based on the program' Compilation of Asian Serial Geological Maps and Research of Related Major Geological Thematic Issues'. The zircon chronological data can precisely reflect the protolith's genetic epochs and their subsequently experienced tectonic-magmatic events. The lithogeochemical data can reflect the chemical features of the rocks themselves. The combination of the above two types of data can provide scientific evidences and basic data support for the study of the crustal evolution in the Northern Liaoning Province. This paper has analyzed the rock samples from the mid-to-high grade metamorphic supracrustal rocks and the tonalitic-trondhjemitic-granodioritic gneiss (TTG gneiss) units in the Qingyuan Complex in Northern Liaoning Province; their rock types include: gneissoid granodiorite, tonalitic gneiss, trondhjemitic gneiss, granodioritic migmatitic gneiss, diopside-amphibolitic leptynite, amphibolitic biotite plagioclase gneiss, gneissoid charnockitic granite, garnet charnockite biotite plagioclase gneiss, granitic gneiss, amphibolitic diopside biotite plagioclase gneiss, metamorphic intermediate volcanic rocks, biotite plagioclase gneiss, plagioclase amphibolite, and sillimanite garnet gneiss. This dataset is of Excel format tables, including 2.xls type files (Zircon_U–Pb dating data_QY.xls, Geochemistry data_QY.xls), which have respectively recorded the zircon U–Pb dating data and the geochemical data of the samples. All the testing process is finished by National Geological Experiment & Testing Center of China with the results being highly reliable.
Key Words: Archean; North China Craton; Qingyuan Complex; zircon geochronological data; lithogeoichemical data.
Data service system URL: http://dcc.cgs.gov.cn

1 Introduction

The North China Craton is one of the world's oldest cratons (Liu et al., 1992, 2008; Wan Yusheng et al., 2009). Scholars now generally accept that the basement of the North China Craton comes from the collisions and collages of multiple micro blocks. But for the amount of the micro blocks, and the ways of their collages as well as their genetic epochs

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remain disputed. Wu Jiashan et al. (1998) debated that the Archean continental crust of the North China Craton could be classified as such 5 blocks as Jiaodong-Liaoning, Qianxi-Huai'an, Shanxi-Hebei, Henan-Anhui, and Mongolia-Shaanxi. At first, the Jiaodong-Liaoning block and Qianxi-Huai'an block were collaged in 2.5 Ga; and later, they were collaged successively with the other 3 blocks, and finally, they were cratonized in 1.8 Ga. Evidenced by the theory of continental nucleus accretion, Zhai et al. (2000) argued that the North China Craton consists of such 6 old continental nucleuses as Jiaodong-Liaoning, Qianxi-Huai'an, Xuchang, Fuping, Jining, and Alxa; these micro blocks had been cratonized through arc-continent collisions at the end of Archean (~2.5 Ga). Nevertheless, other scholars even regard that the North China Craton comes from the collision between the Eastern Block and the Wesatern Block along the central collisional belt at 1.85 Ga, they further suggest that the Eastern Block had experienced Jiaodong-Liaoning-Jilin rifting stage around 1.9 Ga ~ 2.1 Ga, while the west one formed through the collision between the Yinshan Block and Erdos Block along the Khondalite collisional belt around 1.92 Ga (Fig. 1) (Zhao et al., 1999, 2005; Liu et al., 2002; Guo et al., 2012). The last classification scheme is widely accepted by most scholars.

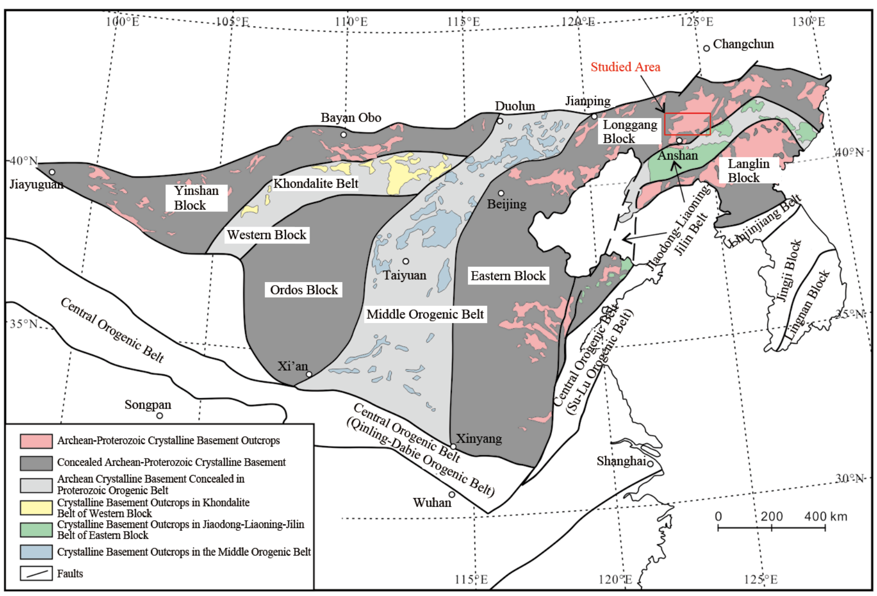

Fig. 1 The Classification of Tectonic Units of the North China Craton Basement, and the Location of the Studied Area (After Zhao et al., 2005)

The Northern Liaoning—Southern Jilin metamorphic Eastern Block and Wesatern Block is located on the north rim of the North China Craton, and is one of the main outcropping area of the North China Craton (Fig. 1). Shen Baofeng et al. (1994) had classified this landmass as two parts: (1) the high amphibolite facies—granulite facies high-graded metamorphic region distributed in the Longgangshan and Hunnan areas, and (2) the epidote amphibolite facies—low amphibolite facies granite-greenstone belt distributed in the Qingyuan, Banshigou, Jiapigou, and Jinchengdong areas. The western part of Northern Liaoning—Southern Jilin metamorphic landmass is connected with the Hebei Chengde—Liaoning Fuxin metamorphic landmass where widely occurs Neoarchean metamorphic supracrustal rocks (2.62~2.50 Ga) and old plutonic intrusives (2.55~2.50 Ga) (Geng et al., 2006; Guo et al., 2013; Wang et al., 2011); whereas its eastern part is connected with the Jiaodong—Liaoning—Jilin tectonic belt which has recorded a large amount of Paleoproterozoic zircon information (2.1~1.9 Ga) (Li et al., 2012); meanwhile, its southern part is connected with the Anshan—Benxi metamorphic landmass where occurs the oldest rocks (~3.8 Ga) of the North China Craton (Liu et al., 1992). In this sense, the Northern Liaoning—Southern Jilin metamorphic landmass acts as an important element that connects the different micro landmasses of the Archean North China Craton; this important position is the key to understand the geological relationship between different metamorphic landmasses (Bai Xiang et al., 2014).

The Qingyuan Complex is an essential component of the Northern Liaoning—Southern Jilin metamorphic landmass, which is mainly composed of TTG gneiss, hypersthene granite, and epicrustal rocks of high amphibolite facies to granulite facies (Shen Baofeng et al., 1994). The testing samples of this paper are mainly collected from this rocks (Fig. 2). TTG gneiss takes more than 50% of the Qingyuan Complex's total volumes, and is mainly distributed in the areas along Hongtoushan Mountains, Hejiapuzi, Shibadaoling, and Shujigou. The diagnostic indicator mineral garnet occurs widely in the rocks, which can be used as the regional correlation index in the whole Qingyuan area (Zhang Yajing et al., 2014). The hypersthene granite usually associates with granulite facies supracrustal rocks; their outcrops, mainly seen along Xianjinchang, Wugoutou, Jingjiagou, and Zhongxintun areas, are not very widespread with the biggest outcropping area being several hundreds of square meters whereas the smallest ones only 10 and odd square meters; especially in the Zhongxintun hypersthene granite complex, usually occur the inclusions of granulite facies supracrustal rocks (Zhang Qiusheng, 1984). The supracrustal rocks are mainly a suite of volcanic rocks (from mafic to felsic) and clastic sedimentary rocks, which are named as, from bottom to top, Jingjiagou Rock Formation (corresponding to the Xiaolaihe Rock Formation in the Hunnan area), Shipengzi Rock Formation, Jinfengling Rock Formation, Hongtoushan Rock Formation, and Nantianmen Rock Formation (Yu Fengjin et al., 2006). Along with the reforms of the later stage tectonic-orogenic events, a series of metallic ore deposits vital to the national economics occur inside the Qingyuan Complex, among of which include the volcanic rocks related massive sulfides ore deposits (e.g., the Hongtoushan type Cu–Zn–Au deposits, and Jishugou Cu–Zn–Au deposits), the banded iron formations (BIF, e.g., Xiaolaihe iron deposit), and the metamorphic hydrothermal vein type gold deposit (e.g., Nanlongwangmiao gold deposit, and Xiadapu gold deposit). Right in this sense, the researches on the Qingyuan Complex are not only helpful to reveal the geological evolution of the North China craton, but also valuable in guiding the ore-searching of important metallic deposits; whereas the zircon chronological studies and the geochemical data collections of the Qingyuan Complex are the bases of these researches.

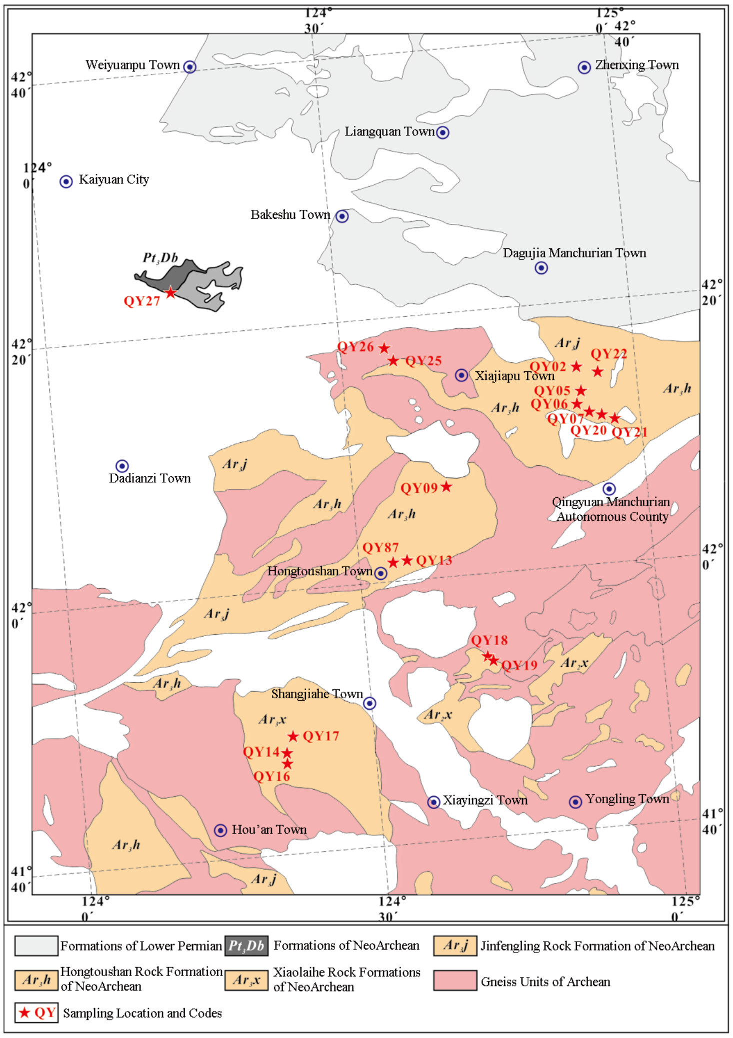

Fig. 2 An Archean Geological Map of Northern Liaoning Area and the Sampling Locations (Simplified after the Digitalized Geological Map of the Same Title at Scale of 1:500, 000)

Table 1 has briefly listed the metadata of the zircon geochronological and geochemical testing database of the Qingyuan Complex in Northern Liaoning Province.

2 Data Collection and Processing Methods

2.1 Sample Collection

Twenty-six items of rock sample in this research are collected by Institute of Geology (affiliated to Chinese Academy of Geological Sciences) from the high-grade metamorphic supracrustal rocks and TTG gneiss units of the Qingyuan Complex in the Northern Liaoning Province. Among these 26 samples, 12 items are dated with zircon U–Pb method; 23 items are analyzed with both zircon U–Pb dating and geochemical testing. The strata of the supracrustal rocks include Xiaolaihe, Jinfengling, and Hongtoushan Rock Formations of Qingyuan Group; their rock types are as plenty as of gneissoid granodiorite, tonalitic gneiss, trondjemitic gneiss, granodioritic migmatitic gneiss, diopside-amphibolite leptynite, hornblende-biotite-plagioclase gneiss, gneissoid hypersthene granite, garnet-hypersthene-biotite-plagioclase-gneiss, granitic gneiss, amphibolite-diopside- biotite-plagioclase geniss, intermediate volcanic rocks, biotite-plagioclase gneiss, plagioclase- amphibolite, and sillimanite garnet gneiss. The sampling locations and the concrete mineral associations are listed in Table 2; the abbreviation of the minerals is adopted after the scheme of Whitney et al. (2010).

Table 1 Metadata table of Database (Dataset)

Items	Description
Database (dataset) name	The dataset of zircon geochronological & geochemical testing of Qingyuan Complex in Northern Liaoning Province
Database (dataset) authors	Li Chong, Institute of Geology, Chinese Academy of Geological Sciences Ren Liudong, Institute of Geology, Chinese Academy of Geological Sciences
Data acquision time	2011—2013
Geographic area	Qingyuan Area, Northern Liaoning
Data format	*.xls
Data size	344 KB
Data service system URL	http://ddc.cgs.gov.cn
Fund project	Geological Exploration Project aided by China Geological Survey (No. 1212011120129)
Language	Chinese
Database (dataset) Composition	The dataset consists of two parts of data: (1) Zircon U–Pb dating data_QY.xls, which is from 12 items of rock sample's zircon U–Pb dating results; each sample has an individual worksheet; each worksheet records the sample numbering, sampling location, rock type, analysis point code, isotopic ratio, age, errs, and other necessary data; (2) Geochemistry data_QY.xls, which is from 23 items of rock sample's geochemical analyses with their sample codes and rock types.

Table 2 Locations, Rock Type, mineral associations and Zircon age of the samples from the Qingyuan Complex in northern Liaoning

Sample No.	Location	Rock Type (Mineral Association)	Zircon age (Ma)
QY02-1	Zhongxin Village, Qingyuan	Gneissoid Granodiorite (hbl, bt, pl, kfs, qtz, ep)	
QY05-1	Siheyong Village, Qingyuan	Gneissoid Hypersthene Granite (bt, hbl, kfs, pl, qtz, opx, ap, mgt)	2528±33 (I); 2506±16(M); 2499±16(R)
QY06-1	Jinquanxian, Qingyuan	Tonalitic Gneiss (hbl, pl, qtz, bt, kfs)	

Continued table 2

Sample No.	Location	Rock Type (Mineral Association)	Zircon age (Ma)
QY07-1	Gounaidianzi, Qingyuan	Tonalitic Gneiss (hbl, pl, qtz, bt, kfs)	
QY09-12	Shujigou, Qingyuan	Trondjemitic Gneiss (kfs, qtz, bt, pl, bt)	
QY13-1	Shibadaoling North, Qingyuan	Granodioritic Migmatitic Gneiss (pl, qtz, ap, ep, chl, cal)	2566±12 (M); 2534±27(R)
QY14-1	Shipengzi Village, Qingyuan	Granodioritic Gneiss (hbl, bt, pl, kfs, qtz, ep)	
QY14-3	Shipengzi Village, Qingyuan	Gneissoid Granodiorite (hbl, bt, pl, kfs, qtz, ep)	
QY16-1(2)	Shipengzi Village, Qingyuan	Tonalitic Gneiss (hbl, pl, qtz, bt, kfs)	
QY16-8	Shipengzi Village, Qingyuan	Gneissoid Granodiorite (hbl, bt, pl, kfs, qtz, ep)	
QY17-1	The north of Shipengzi Village, Qingyuan	Diopside Amphibolitic Leptynite (hbl, pl, cpx, ap, mgt, qz)	2527±15 (I); 2511±18(M); 2501±31(R)
QY18-5	Xiaolaihe Iron Deposit, Qingyuan	Trondjemitic Gneiss (kfs, qtz, bt, pl, bt)	
QY18-7	Xiaolaihe Iron Deposit, Qingyuan	Granodioritic Gneiss (pl, qtz, ap, ep, chl, cal)	
QY18-8	Xiaolaihe Iron Deposit, Qingyuan	Tonalitic Gneiss (hbl, pl, qtz, bt, kfs)	
QY19-1	Lower Part of Mining Pit, Xiaolaihe Iron Deposit, Qingyuan	Amphibolite-biotite-plagioclase Gneiss (bt, pl, hbl, kfs, qz, ap, cal, chl)	2525±25 (I); 2497±15(M); 2505±38(R)
QY20-1	South of Gounaidianzi, Qingyuan	Granitic Gneiss (Opx, cal, bt, qz, kfs, pl, amp, sph)	2495±21 (M); 2455±30(R)
QY20-2	South of Gounaidianzi, Qingyuan	Amphibolite-diopside-biotite-plagioclase Gneiss(bt, cpx, hbl, pl, kfs, qz, ep, amp, ap)	2492±22 (M); 2467±23(R)
QY21-1	South of Gounaidianzi, Qingyuan	Garnet-hypersthene-biotite-plagioclase Gneiss (bt, grt, pl, opx, qz)	2528±22 (I); 2494±33(M); 2479±21(R)
QY22-7	Northeast to Xianjinchang, Qingyuan County	Gneissoid Granodiorite (hbl, bt, pl, kfs, qtz, ep)	
QY25-1	The South of Xiaogujia, Qingyuan	Amphibolite-biotite-plagioclase Gneiss (TTG) (bt, pl, hbl, ep, cal)	2492±21(M); 2467±13(R)

Continued table 2

Sample No.	Location	Rock Type (Mineral Association)	Zircon age (Ma)
QY26-1	Weizi South, Northern Qingyuan	Gneissoid Granite (pl, kfs, qtz, bt, hbl)	
QY26-2	Weizi South, Northern Qingyuan	Gneissoid Granite (pl, kfs, qtz, bt, hbl)	
QY27-1	Mamahuolang, Kaiyuan	Intermediate Volcanic Rocks (pl, bt, ep, chl, kfs, amp)	2504±25 (M); 2468±15(R)
QY87-1	The Rear Ridge, Hongtoushan Mining Area	Sillimanite-garnet Gneiss (sil, grt, ky, st, ged, opx, bt, qz, pl)	2509±8 (M); 2497±7(R)
QY87-2	The Rear Ridge, Hongtoushan Mining Area	Plagioclase Amphibolite (pl, ged, qtz)	2538±12 (M); 2528±17(R)
QY87-8	The Rear Ridge, Hongtoushan Mining Area	Biotite-plagioclase Gneiss (bt, grt, opx, rt, qtz, pl)	2560±12 (M); 2528±18(R)

2.2 Testing Methods

This paper has carried out zircon dating and geochemical analysis for the rock samples from the high-grade metamorphic supracrustal rocks and TTG gneiss unit in the Qingyuan Complex in Northern Liaoning Province. The separation of zircon samples was finished by the laboratory of Langfang Chengxin Geological Services Company (Hebei Province); the samples were crushed, washed, dried, and screened; and then the magnetic separation and density separation were applied to pick out the pure zircon grains. Under the binocular, the zircon grains with larger sizes and perfect shapes were selected out. Zircon's cathodoluminescence images and backscatter images were obtained on the scanning electron microscope branded with LA−ICP−MS FEI PHILIPS XL30 SFEG, which is owned by Institute of Mineral Resources, Chinese Academy of Geological Sciences. Zircon dating was prepared after the selection of zircon grains by cathodoluminescence images, transmitted images, and backscatter images. The zircon U−Pb LA−ICP−MS dating was finished on the Thermo Element II mass spectrometer by China National Geological Experimental Testing Center. The supporting gas of denuding materials was He; the zircon age was corrected with the standard zircon GJ–1 and Plesovice which were used as the two exterior standard materials; the two exterior standard samples were respectively tested additionally every five samples. The raw data are processed with GLITTER software; the zircon ages concordancy diagram was finished applying the ISOPLOT 3.0 software (Ludwig, 2003). The whole-rock geochemical analysis was finished by the China National Geological Experimental Testing Center. The testing of the contents of major elements of the above-mentioned samples was finished with the XRF method; the rare earth element testing and microelement testing were done with ICPMS method. Among all the testing and analysis, the errors of the whole-rock major element analysis are better than 5%; in the microelement testing, when the element content is bigger than 10×10^{-6}, the error is less than 10%.

3 Description of Data Samples

The Dataset of Zircon Geochronological and Geochemical Testing of Qingyuan Complex in Northern Liaoning Province is of Excel format table-type data, including such 2 Excel data files as (1) Zircon_U−Pb dating data_QY.xls, and (2) Geochemistry data_QY.xls. The file (1) describes the U−Pb age information of the samples in the studied area, including 12 items of zircon dating samples, each with an individual work sheet comprising of Sample Codes, Sampling Location, Rock Type, Analysis Point Code, Th/U Ratio, Isotopic Ratio, Ages, Errors, and other data (as shown in Table 3); while the file (2) includes such information as each sample and its code, rock type, and geochemical data of the 23 testing samples (as listed in the Table 4).

Table 3 Zircon U-Pb Isotopic Dating Results

Sample No.	Character									
Sample Location	Character									
Rock Type	Character									
LA−ICP−MS Zircon Analysis Data and Age Values										
Analysis Point	Isotopic Ratios				Apparent Ages (Ma)					
	$^{207}Pb/^{235}U$	±1δ	$^{206}Pb/^{238}U$	±1δ	$^{206}Pb/^{238}U$	±1δ	$^{207}Pb/^{236}U$	±1δ	$^{207}Pb/^{238}U$	±1δ
Character	float	float	float	float	float	float	float	float	float	float
Character	float	float	float	float	float	float	float	float	float	float
Practical Example										
Sample No.	QY05-1									
Sample Location	Siheyong Village, Qingyuan, Liaoning Province									
Rock Type	Gneissoid Hypersthene Granite									
LA−ICP−MS Zircon Analysis Data and Age Values										
Analysis Point	Isotopic Ratios				Apparent Ages (Ma)					
	$^{207}Pb/^{235}U$	±1δ	$^{206}Pb/^{238}U$	±1δ	$^{206}Pb/^{238}U$	±1δ	$^{207}Pb/^{236}U$	±1δ	$^{207}Pb/^{238}U$	±1δ
QY05-1_1	11.13	0.23	0.48	0.01	2502	33	2534	19	2533	38
QY05-1_2	10.66	0.22	0.47	0.01	2442	33	2494	19	2493	38

Table 4 Lithogeochemical Data

Rock Type	Character	Character	Character	Character	Character	Character	Character	Character	Character
Sample No.	Character	Character	Character	Character	Character	Character	Character	Character	Character
Element	float	float	float	float	float	float	float	float	float
Practical Example									
Rock Type	Gneissoid hypersthene granite	Granodioritic Migmatite	Diopside--amphibolite leptynite	Amphibolite--biotite--plagioclase Gneiss	Granitic Gneiss	Amphibolite-diopside--biotite-plagioclase Gneiss	Garnet-hypersthenite-biotite--plagioclase Gneiss	Amphibolite-biotite--plagioclase Gneiss	Intermediate Volcanic Rocks
Sample No.	QY05-1	QY13-1	QY17-1	QY19-1	QY20-1	QY20-2	QY21-1	QY25-1	QY27-1
SiO_2 (%)	68.05	64.60	56.89	63.50	70.23	58.20	61.14	60.37	59.76

4 Data Quality Control and Evaluation

The zircon geochronological dating and geochemical testing were both finished in China National Geological Experimental Testing Center. All the testing procedures were fulfilled according to the strict international standards. Because of the complicate tectonic evolution of the Qingyuan Complex in the Northern Liaoning Province, the zircon samples were usually of multi-staged growth striations. Before the zircon dating tests, the zircon target was scanned under the transmitted microscope and cathodoluminescence so as to pick out the suitable zircon grains and allocate the best testing points on the zircon grains, and to avoid getting insignificant testing results (false zircon ages) on the fissures or the growth boundaries of the tested zircon grains. The processes of LA–ICP–MS zircon U−Pb dating tests in this research are basically the same with that of Hou Kejun et al. (2007); the GJ–1 zircon (the standard sample of Australia MacQuarie University's Continental Geochemistry & Metallogenesis Research Center Laboratory) and the Plesovice zircon (the measured standard of the U–Pb dating by Norway University of Bergen's Geosciences Department Laboratory) were used as the exterior standards to correct the testing results. The measured U−Pb data points in this research are basically allocated on the concordant line; meanwhile, the measured zircon ages (testing results) are correlative to that of the other scholars in the same geographical regions (Wan Yusheng et al., 2005; Grant et al., 2009; Bai Xiang et al., 2014).

5 Conclusions

The Dataset of Zircon Geochronological and Geochemical Testing of Qingyuan Complex in Northern Liaoning Province is of Excel format table-type data, including 2 Excel data files, respectively as Zircon_U−Pb dating data_QY.xls, and Geochemistry data_QY.xls. Among these two files, the first one describes the U−Pb ages of the samples collected from the studied area, including 12 zircon dating samples, each with an individual work sheet comprising of such entries as Sample Codes, Sampling Location, Rock Type, Analysis Point Code, Th/U Ratio, Isotopic Ratio, Ages, Errs, and other data;

while the latter file includes such information as each sample and its code, rock type, and geochemical data of the 23 testing samples. This dataset could offer the key basic data for the researches on the geological evolution of the North China Craton, and for the ore-searching in the Northern Liaoning Province.

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