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河北省崇礼幅 1∶50 000 矿产地质图数据库

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摘要: 根据《固体矿产地质调查技术要求 (1∶50 000)》(DD 2019–02) 和行业其他规范要求，完成河北省崇礼幅 1∶50 000 专项地质填图 379.93 km^2、矿点检查 11 处，采集水系沉积物样品 1622 件、重力测量物理点 1623 个，测试锆石 U–Pb 年龄样 3 组、流体包裹体样 80 余件，系统编制了河北省崇礼幅 1∶50 000 矿产地质图，并建立了数据库。突出了对燕山期岩浆岩和相关脉岩、碱性杂岩体和谷嘴子岩组、矿化蚀变等相关成矿信息的表达，厘定了崇礼幅中太古代、新太古代的变质深成侵入体，划分了海西期、印支期、燕山期的岩浆岩建造类型，划分了张家口组火山岩的 7 个建造类型、谷嘴子岩组变质岩的 3 个建造类型，系统总结了该区金矿的成矿地质体、成矿构造及成矿结构面、成矿作用特征标志。该数据库为该区金矿的找矿工作提供了基础数据支撑，对金矿目标层地质信息和构造建造信息的提取提供了便利条件，对今后矿产勘查部署具有一定的参考价值。

关键词: 1∶50 000；矿产地质图；数据库；地质调查项目；崇礼幅；河北

数据服务系统网址: http://dcc.cgs.gov.cn

1 引言

崇礼幅 (K50E019006) 位于张家口市 NE 约 30 km，地处华北克拉通北缘中段 (图 1a[1])，燕山山脉西缘。区内矿产资源丰富，是太行–燕辽造山带的重要组成部分 (邓晋福等，2009)。本区矿产类型主要为热液型金矿、沉积变质型铁矿、陆相次火山岩型铅锌矿，此外还发育有磷矿、石墨等非金属矿产。目前，张家口市宣化–赤城–崇礼 3 区县交界“金三角”已发现金矿产地 60 余处，其中大型 2 处（小营盘、东坪）、中型

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4 处（大白阳、后沟、张全庄、黄土梁）、小型 20 余处。这些金矿在空间上均直接或间接地受控于中太古代谷嘴子岩组和海西期水泉沟碱性杂岩体。结合矿床地质地球化学特征，区内金矿可划分为 3 种类型，即东坪式、小营盘式、张全庄式（表 1）。

张家口地区的地层主要为太古宙、古元古代的变质岩系，古生代—中生代的沉积岩系和侏罗–白垩系火山–沉积岩系。其中，中太古代谷嘴子岩组主要分布在尚义—崇礼—赤城断裂以南地区，与区内金矿具有密切的空间关系 (图 1b[1])。区内构造活动频繁，具有长期活动的特点，断裂极为发育。其中，尚义—崇礼—赤城断裂走向 EW，全长 470 km，为区内重要的控岩控矿构造；上黄旗—乌龙沟断裂走向 NNE，全长 250 km，具有复杂的演化历史，周边出露大面积的燕山期花岗岩和火山岩[2]。区内褶皱构造主要发育于古太古代桑干群和新太古代红旗营子群。褶皱轴向主要为 NW–SE，NW 端倾伏、SE 端扬起。区内岩浆岩具有多期次、分布广及岩石类型丰富的特点 (图 1b)。海西期、印支期、

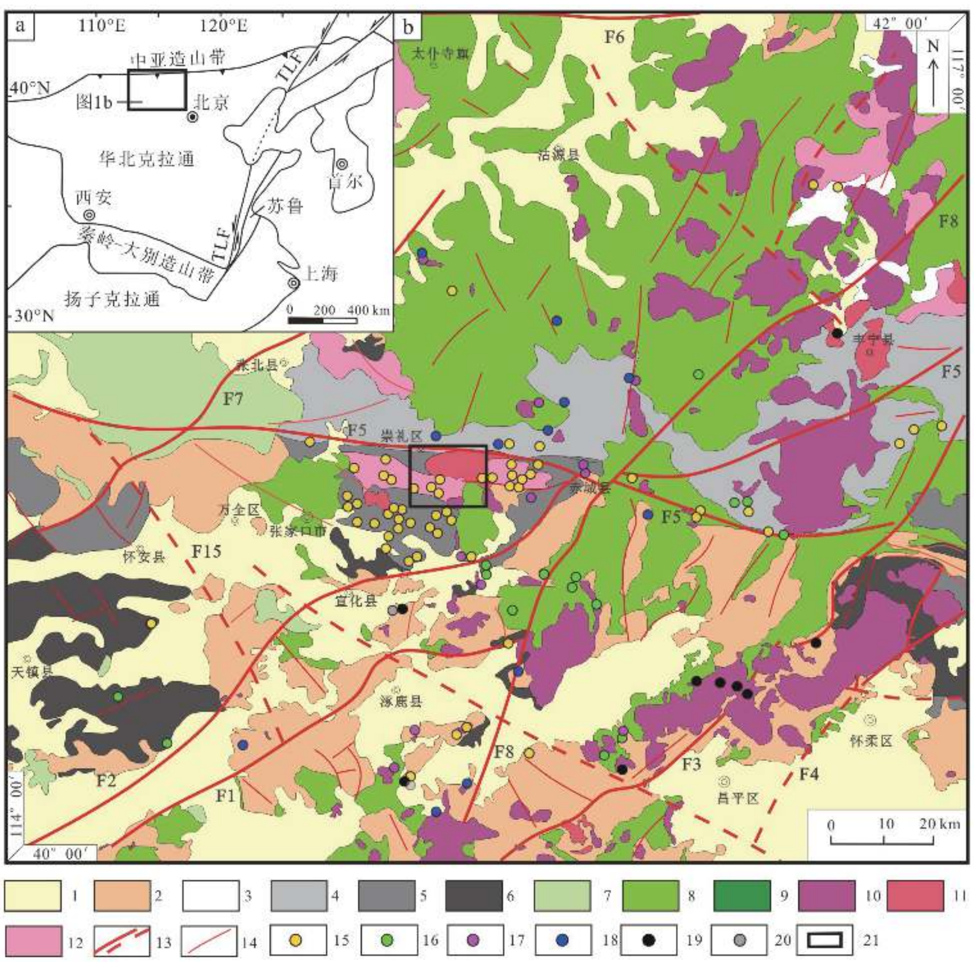

图 1　河北省崇礼幅大地构造位置 (a) 及区域地质简图 (b)(据甄世民等，2019[1] 修编)

1—第四系；2—古生代–中生代沉积岩系；3—古元古代变质岩系；4—新太古代变质岩系；5—中太古代变质岩系；6—古太古代变质岩系；7—喜马拉雅期火山岩；8—燕山期火山岩；9—印支期火山岩；10—燕山期侵入岩；11—印支期侵入岩；12—海西期侵入岩；13—实测 (推断) 深大断裂；14—一般断裂；15—金矿；16—铜矿；17—银矿；18—铅锌矿；19—钼矿；20—钨矿；21—研究区范围；TLF—郯庐断裂带；F1—桑干—平泉构造 (结合) 带南界深大断裂；F2—桑干—平泉构造 (结合) 带北界深大断裂；F3—紫荆关—灵山断裂带；F4—太行山山前断裂带；F5—尚义—崇礼—赤城断裂带；F6—康保—围场断裂带；F7—张北—沽源断裂带；F8—上黄旗—乌龙沟断裂带；F15—马市口—松枝口断裂

表 1　冀西北地区金矿类型及特征简表

矿床特征	东坪式	小营盘式	张全庄式
矿床规模	大型	大型	中型
赋矿围岩	碱性杂岩体	斜长角闪质岩石（麻粒岩、变粒岩、混合岩）	斜长角闪质岩石，超基性岩
矿石（脉）类型	贫硫化物石英脉型为主，部分蚀变岩型	贫硫化物石英脉型为主，部分蚀变岩型	富硫化物石英脉型
矿体形态、产状及规模	主矿脉5条，长数百～千余米，厚0.24～5.10 m，延深10～400 m以上，主矿脉倾向NW，倾角30°～55°。矿体呈脉状、似层状、透镜状。矿脉由石英单脉及其上下盘石英复脉、羽状支脉、钾化、硅化及钾化二长岩组成	主矿脉沿走向长2500～3500 m，倾斜延深3700 m，分布面积达12 km^2。矿体受同一缓倾斜石英脉控制。矿体最厚达21 m。单个矿体以似层状、扁豆状、透镜状为主	含金石英脉有50余条。长度10～2200 m，矿体主要为透镜状。主矿脉平均走向325°，倾向NE，倾角60°～80°；有尖灭再现现象，矿体厚0.2～2 m，延深>200 m
围岩蚀变类型	钾长石化、硅化、绢云母化，绿帘石化、碳酸盐化，重晶石化，高岭土化，褐铁矿化，钠长石化	钾长石化、硅化、碳酸盐化，绢云母化、绿泥石化、褐铁矿化、高岭土化	硅化、绢云母化、绿泥石化、绿帘石化，碳酸盐化、高岭土化
主要矿物组合	石英、钾长石、斜长石、赤铁矿、镜铁矿、褐铁矿、黄铁矿、方铅矿、黄铜矿、自然金、碲金矿、黝铜矿、斑铜矿、铜兰、雌黄铁矿	石英、钾长石、黄铁矿、方铅矿、黄铜矿、镜铁矿、钼铅矿、赤铁矿、褐铁矿、自然金、银金矿、孔雀石、碲金矿、辉银矿、方解石	石英，钾长石、黄铁矿、方铅矿、黄铜矿、钛铁矿、自然金、银金矿、铁白云石、方解石
矿石组构	浸染状、条带状，斑杂状构造；自形-半自形粒状交代、乳滴状、包含结构等	脉状、浸染状构造；自形-他形粒状交代残余、交代假象结构及碎裂结构等	脉状、浸染状、团块状构造；自形-他形粒状、交代残余、交代假象、溶蚀结构及碎裂结构等
金品位（g/t）	一般为3.2～571，平均5～20	1.5～30，最高154.05，平均9.68	一般<30，最高368.59，平均14.3
同位素地球化学特征	$\delta^{34}S$变化范围大；$^{206}Pb/^{204}Pb$比值相对较高，落在造山带和下地壳铅同位素演化线之间；$\delta^{18}O_{H2O}$较δD的分布范围广；较低的$^{40}Ar/^{36}Ar$比值	$\delta^{34}S$主要为负值，无正值出现；$^{206}Pb/^{204}Pb$比值相对较低，主要落在地幔和下地壳铅同位素演化线之间；$\delta^{18}O_{H2O}$值较高且变化范围小；较高的$^{40}Ar/^{36}Ar$比值	$\delta^{34}S$为0附近的正值；$^{206}Pb/^{204}Pb$比值相对较低，主要落在地幔和下地壳铅同位素演化线之间；$\delta^{18}O_{H2O}$值较高但变化范围大；中等的$^{40}Ar/^{36}Ar$比值
同类矿床	东坪、黄土梁、中山沟、后沟、赵家沟、西坪、杨木洼等	小营盘、大白阳、水晶屯、黑土沟、席麻湾等	张全庄、大营盘、响水沟、金家庄等

注：据Wang DZ et al., 2020a；Zhen SM et al., 2020a,2020b；银剑钊和翟裕生，1994；胡小蝶等，1997；甄世民等，2019[1]修编。

燕山期均有岩浆岩侵入，岩性以中酸性岩浆岩为主。燕山期的构造岩浆岩带总体上受上黄旗—乌龙沟、紫荆关—灵山、张北—沽源 NNE 向断裂带控制 (图 1b)；同时，又受 EW 向基底构造和断裂构造控制，如尚义—崇礼—赤城断裂带。

崇礼幅工作区属宣化—赤城—崇礼三区县交界“金三角”的组成部分。该区已经勘查发现有东坪大型碲金矿床、三道沟小型铅锌矿、窑子湾小型铁矿等。本次主攻矿床类型为“东坪式”金矿。崇礼幅已在 20 世纪 80 年代完成 1：50 000 区域地质调查和水系

沉积物测量❸等工作。但是，图幅内尚未系统开展过 1：50 000 矿产地质调查工作，尤其对成矿地质体、成矿构造及成矿构造面、成矿作用特征标志等未开展过系统调查研究。成矿规律研究总结不足严重制约了本区的进一步找矿勘查。本次 1：50 000 矿产地质调查与研究大致查明了区域成矿地质条件和矿产资源特征，分析了金矿控矿因素，揭示了金矿的区域成矿规律、评价了区域金矿资源潜力，提高了区内矿产地质调查程度和研究水平，提升了区内矿产地质工作服务资源安全、经济社会发展、生态文明建设的能力。

2 数据采集和处理方法

2.1 数据基础

河北省崇礼幅 1：50 000 矿产地质图以“三位一体”勘查区找矿预测理论为指导 (叶天竺等，2014，2017)，以《固体矿产地质调查技术要求 (1：50 000)》(DD 2019–02) 为基本要求，以 1：50 000 区域地质调查❸原始资料 (包括实际材料图、剖面图、记录本) 为基础，在河北省矿产资源潜力评价基础上，充分利用 1：250 000、1：200 000 区域地质调查成果资料，最终编制而成。地理信息底图采用国家 2000 大地坐标系 (CGCS 2000)。应用已有的技术标准和数字填图系统 (DGSS)、MapGIS 等计算机软件进行数据处理。在此基础上，充分结合本次地质填图和研究成果。

河北省崇礼幅 1：50 000 矿产地质图数据库（甄世民等，2020）的元数据按照《地质信息元数据标准》(DD2006–05) 执行，简表如表 2 所示。

表 2　崇礼幅 1：50 000 矿产地质图数据库元数据简表

条目	描述
数据库名称	河北省崇礼幅1：50 000矿产地质图数据库
数据库作者	甄世民，中国地质调查局发展研究中心 白海军，河北省地矿局第三地质大队 缪建普，河北省地矿局第三地质大队 贾儒雅，中国地质调查局发展研究中心 姚磊，中国地质调查局发展研究中心
数据时间范围	2016—2018年
地理区域	经纬度：东经 115°15′～115°30′，北纬 40°50′～41°00′
数据格式	MapGIS
数据量	15.7 MB
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“全国重要矿集区找矿预测”(DD20160052)资助
语种	中文
数据库(集)组成	崇礼幅1：50 000矿产地质图数据库包括1：50 000地质图库和图饰。地质图库包括沉积岩、岩浆岩、火山岩、变质岩、第四系、脉岩、构造、地质界线、产状、矿床(点)、蚀变、岩性花纹、各类代号等。图饰包括：接图表、柱状图、图例、图切剖面、典型矿床矿脉群平面分布图、典型矿床剖面图、矿产地名录、所属大地构造位置图、责任表等

为编制崇礼幅 1：50 000 矿产地质图，收集和修编 1：50 000 区域地质调查路线长度约 870 km❸，路线约 145 条，利用前人锆石 U–Pb 年龄数据约 14 组、岩石全分析样品数据约 30 组；实测地质路线长度约 300 km，矿点检查 11 处，实测锆石 U–Pb 年龄数

据 3 组 (表 3)，照片 500 余张，流体包裹体 80 余件等。同时，充分利用前人对该地区矿产勘查[4]、典型矿床研究 (宋国瑞和赵振华，1996；Mao JW et al.，2003；Cisse et al.，2017；Wang DZ et al.，2020b) 等方面的成果。

表 3　崇礼幅岩浆岩锆石 U–Pb 年龄一览表

序号	样品描述	U–Pb年龄/Ma	数据来源
1	水泉沟二长杂岩	390±6	罗镇宽等，2001
2	东坪金矿含金石英脉的热液锆石	380.5±2.6	李长民等，2010
3	红花梁二长花岗岩	235±2	Jiang N et al.，2007
4	上水泉子黑云母花岗岩	142.2±1.3	Miao LC et al.，2002
5	东坪金矿斑状花岗岩	142.06±0.84	Wei H. et al.，2018
5	转枝莲辉石闪长岩	139±0.9	Jiang N et al.，2007
6	张家组流纹岩	135±2	本次工作
7	北栅子黑云母二长花岗岩	130±2	本次工作
8	二长斑岩	125.9±2.2	本次工作

2.2　数据处理过程

2.2.1　数据准备

将收集到的 1：50 000 区域地质调查成果和实际材料图进行数字化处理，形成 MapGIS 点、线、面文件。根据范围生成崇礼幅 1：50 000 标准图框，投影系统为高斯–克吕格投影，坐标系统为 CGCS 2000。

2.2.2　编制建造构造草图

通过查阅和分析崇礼幅 1：50 000 区域地质调查报告中涉及的实测剖面、野外地质记录等实际材料[3]，分解组一级编图单元，补充岩性 (组合) 界线，并将野外记录以岩性建造花纹点或线的形式表达在实际材料图上。

(1) 建造

按照统一的用色标准，使用不同颜色的面元表达建造的时代，使用建造花纹表达建造类型，并用相应的花纹表达岩石组合，代号用“岩性+时代”表达。如海西期水泉沟碱性杂岩体按照颜色、矿物组成、矿物粒度等划分为 6 个岩性组合，并按照相应的花纹、颜色表达建造含义。

(2) 岩脉

按照统一的用色标准使用面元的颜色表达岩性，代号用岩性代号表示。

(3) 构造

按照统一的用色标准使用红色统一表示，用不同线型表达断裂性质。

(4) 地质剖面

使用“标准剖面线型+剖面代号”表达位置，并以地质点及编号表达实际控制点情况，以相应的花纹表达各层岩性，同时在地质剖面上表达产状要素。

(5) 岩石化学、地球化学、同位素样品采样点

使用“标准子图号+样品编号”表达采样点位置，并建立数据库。

2.2.3　野外专项地质填图

根据对已有资料的综合分析和建造构造草图的整理，划分重点调查区和一般调查

区，确定了专项地质填图重点内容为燕山期侵入岩、矿化蚀变、构造、中酸性脉岩等。以数字填图掌上电脑中 1：25 000 实际材料图为底图，通过野外实际路线调查，在数字填图系统中标绘出地质点、界线点和地质界线及路线等点、线信息，观察并录入各点的性质、岩性、产状等信息，初步建立数字填图 (PRB) 数据库。

地质点 (P)：分为界线点和观测点。在野外需要在系统中填写简单的属性，包括点号、点性、微地貌、露头情况、风化程度、位置说明、填图单元和接触关系，坐标信息由系统自动读取。

地质路线 (R)：野外需要在系统中填写的属性包括路线号、地质点号、路线编号、方向角、本站距离、累计距离、填图单元和岩石名称。其中，方向角、本站距离、累计距离为系统自动计算所得。

地质界线 (B)：野外需要在系统中填写的属性包括路线号、地质点号、B 编号、R 编号、界线类型、左侧填图单位、右侧填图单位、接触关系、走向、倾向和倾角。

对沿途所见的地质产状和采集的标本等相关信息，可随时在系统中定位录入，填写属性数据。

2.2.4　室内数据整理

(1) 将野外采集的地质点 (P)、地质路线 (R)、地质界线 (B) 数据资料导入电脑中，并根据相应规范进行数据整理。

①地质点 (P) 数据处理过程及基本要求：路线号、风化程度、接触关系等信息按照实际情况填写完整，填图单位填写相应填图单元代号，岩石名称与地质描述对话框中保持一致 (包括颜色、结构、构造等)，批注信息为薄片鉴定结果，并根据实际情况综合定名后填写。

②地质路线 (R) 数据处理过程及基本要求：在室内按照“光滑曲线→修改线参数 (线性 1，颜色 1，线宽 0) →点间路线计算→(统计工作量)”等技术要求进行。补充完善 R 属性数据库，并在进行路线地质描述前重新计算方位和距离。

③地质界线 (B) 数据处理过程及基本要求：在室内计算机上用剪短线、延长线或者重新画线的方法按照接触情况对地质界线进行美化。统一颜色、线性、线宽等参数。补充地质界线描述信息，用“左侧为×××，右侧为×××”来说明界线两侧岩性，默认左侧为先观察的岩性，右侧为后观察到的岩性，并对两种岩性的接触关系及其证据加以表述。

④路线中的产状、采样、照片基本要求：补充产状、采样等相应属性描述信息。产状编号在变换地质点后重新从 1、2、3 等开始编号，照片按照要求导入后在照片详细描述中对照片内容及所反映地质现象进行描述。

(2) 将本次野外实际采集的 PRB 数据为主的实际材料图与编制建造构造草图时整理的区域地质调查实际材料图进行合并，对地层单元界线、建造花纹、反映各类建造的构造形态进行修正，对新形成的地质单元的界线进行勾连。

2.2.5　编制各类辅图

(1) 建造柱状图：对主图中岩石地层单元的建造特征进行详细表达。通过对图幅内各类建造与构造及其与矿化的关系进行综合分析研究，编制沉积岩建造柱状图、火山岩建造柱状图、侵入岩建造柱状图、变质岩建造柱状图。

(2) 典型矿床辅图：在收集以往研究成果的基础上，充分利用本次典型矿床野外实

地调查与综合研究的成果，编制了典型矿床的辅图部分，包括东坪金矿矿脉群 (带) 分布图、主要矿体平面分布略图、7 勘探线剖面图等。

(3) 图切剖面：图幅内建造和构造的总体走向特征为 NWW 向、EW 向和 NNE 向，为了有效反映图幅内总体建造和构造特征及其与矿化的关系，布置了 NS 向、NW 向 2 条贯穿全区的图切剖面，分别控制中太古代变质岩、中泥盆世二长岩、晚三叠世二长花岗岩、早白垩世花岗岩和火山岩。表达方式主要使用了标准剖面线型+标准代号表示位置，并以地质点及编号表达实际控制点情况，以相应的花纹表达各层岩性，同时在地质剖面上表达产状要素。

(4) 矿产地名录：对本区的矿产地按照矿产地名称、规模、类型、主要含矿建造等方面进行了分析，编制矿产地名录。

(5) 大地构造位置图：表达了崇礼幅所处的区域大地构造位置。在收集全国矿产资源潜力评价资料和河北省矿产资源潜力评价资料的基础上[❷❺]，根据图幅位置确定区域轮廓范围对本图进行裁剪，保留Ⅰ–Ⅳ大地构造单元和主要的地名和金矿。然后进行缩放，生成崇礼幅所属大地构造位置的辅图部分。

(6) 其他辅图：对脉岩、构造、矿化蚀变图例进行梳理，编制各种图例。

3　数据内容描述

3.1　数据的命名方式

应用 MapGIS 软件的数据命名方式，即地质面.wp，地质线.wl，地质点.wt。

3.2　图层内容

主图内容包括沉积岩建造、火山岩建造、侵入岩建造、变质岩建造、构造、地质界线、产状、矿产地、矿化蚀变、各类代号、地理信息等。

辅图内容包括接图表、建造柱状图、图例、图切剖面、典型矿床矿脉群 (带) 分布图、典型矿床勘探线剖面图、矿产地名录、大地构造位置图、责任表等。

3.3　数据类型

实体类型名称：点、线、面。

点实体：各类地质体符号及标记、地质花纹、矿产地、矿化蚀变。

线实体：断裂构造、地质界线、岩相界线等。

面实体：沉积岩、火山岩、变质岩、侵入岩、第四系、脉岩等。

3.4　数据属性

崇礼幅 (K50E019006)1：50 000 矿产地质图数据库包含地质实体要素信息、地理要素信息和地质图整饰要素信息。地理要素信息属性沿用国家测绘地理信息局收集数据的属性结构。地质实体要素信息属性按照 1：50 000 矿产地质调查数据库建库要求，四大岩类 (沉积岩、火山岩、侵入岩、变质岩)、断裂构造、产状要素、矿产地等分别建立数据库属性 (表 4)。数据库属性参照《成矿地质背景研究技术要求》(叶天竺等，2010)、《成矿地质背景研究数据模型》(左群超，2011)、《矿产资源潜力评价数据模型：数据项下属词规定》(左群超，2012) 等执行。

表 4 崇礼幅矿产地质图数据属性简表

编号	数据项	数据属性
1	沉积岩建造	年代地层单位、岩石地层单位、建造名称、建造代码、岩性组合、地层时代、建造厚度、建造含矿性、岩石结构、沉积构造、岩石颜色、沉积作用类型、沉积相类型、同沉积构造等
2	火山岩建造	年代地层单位、岩石地层单位、建造名称、建造代码、地层时代、地层分区、岩性组合、建造厚度、建造含矿性、火山喷发旋回、火山喷发类型、火山岩成因类型、特殊岩性夹层、火山岩相类型、同位素年龄等
3	侵入岩建造	建造名称、建造代码、岩性组合、建造含矿性、岩石结构、岩石构造、侵入期次、岩体产状、平面形态、剖面形态、岩体侵位构造特征、接触带特征、成因类型、同位素年龄等
4	变质岩建造	年代地层单位、岩石地层单位、建造名称、建造代码、岩性组合、地层时代、建造厚度、建造含矿性、岩石结构、岩石构造、原岩建造、变质相、变质作用类型等
5	断裂构造	断裂名称、断裂类型、断裂延长、断裂延深、断裂宽度、断裂走向、断裂面倾向、断裂面倾角、断距、断裂面形态、构造岩特征、运动方式、活动期次、力学性质等
6	产状	产状类型、倾向、倾角等
7	矿产地	矿产地编号、矿产地名称、矿产地类别、地理经度、地理纬度、矿种、矿床成因类型、规模、共(伴生)矿产、查明资源量等

4 数据质量控制及监控

本次调查工作严格按照中国地质调查局《1：50 000 矿产地质调查工作指南 (试行)》(中地调函 [2016]117 号) 和《固体矿产地质调查技术要求 (1：50 000)》(DD 2019–02) 执行。填图采用填编结合的方法，重点调查区以实测资料为主，一般工作区以《下两间房幅 K–50–111–A、崇礼幅 K–50–111–B、镇宁堡幅 K–50–111–A 1：50 000 区域地质调查报告》[3] 原始资料为主。地质点密度以充分控制与成矿有关的地质体、矿化蚀变带、重要地质界线等为原则合理安排。图面表达一般只表达直径大于 100 m 的闭合地质体，宽度大于 50 m、长度大于 250 m 的线状地质体，以及长度大于 250 m 的断层、褶皱构造。对矿化蚀变构造带及其他矿化地质体规模不论大小，均在图上表示；厚度较小者，用适当的花纹、符号放大或归并表示。地质点在野外手图上所标定的点位与实地位置误差不得大于 25 m。调查区整体工作精度达到 1：50 000 比例尺的要求。

项目野外实施过程中，按照中国地质调查局《地质调查项目管理办法》(中地调发〔2011〕18 号) 相关要求，严格执行“三级质量检查制度”，其中原始资料自检、互检比例均为 100%，项目组检查比例大于 50%，质检组抽查比例大于 15%，保证了资料数据的质量。样品测试分析均在符合资质要求的实验室进行，分析过程进行了内外部监控，分析质量符合要求。

5 数据价值

河北省崇礼幅 (K50E019006)1：50 000 矿产地质图是中国地质调查局开展新一轮矿产地质调查工作的示范图幅之一。该矿产地质图按照《固体矿产地质调查技术要求 (1：50 000)》(DD 2019–02) 要求，在深入研究图幅内建造构造的基础上，结合本次 1：50 000 专项地质填图成果，将综合研究贯穿于调查全过程，突出表达了与中低温热液型金矿相关的地质体。其中，收集和补充了各期次岩体的锆石 U–Pb 测年，归纳出图幅内中太古代、新太古代的变质深成侵入体，划分了海西期水泉沟碱性杂岩体的 6 个建造类型、印支期红花梁岩体的 1 个建造类型，梳理出了燕山期上水泉岩体黑云母花岗

岩、转枝莲岩体辉石闪长岩、北栅子岩体黑云母二长花岗岩 3 个建造类型 (表 5)，建立了岩浆岩的成岩谱系；归纳出了张家口组火山岩的 7 个建造类型 (表 6)；对变质岩地层进行了重新划分，将谷嘴子岩组、太平庄岩组分别划分为 3 个建造类型 (表 7)。

表 5　侵入岩建造一览表

时代				建造单元特征				
代	纪	世	期	代号	建造类型	岩性组合	锆石U–Pb同位素年龄/Ma	矿化蚀变特征
中生代	白垩纪	早白垩世		$\eta\gamma\beta K_1$	黑云母二长花岗岩建造	灰白色中细粒黑云母二长花岗岩	130.5	
				$\varphi\delta K_1$	辉石闪长岩建造	深灰色中细粒–中粒辉石闪长岩	139.5±0.9	
				$\gamma\beta K_1$	黑云母花岗岩建造	浅肉红色中粒–中粗粒黑云母花岗岩	142	
	三叠纪	晚三叠世		$\eta\gamma T_3$	二长花岗岩建造	灰白色、浅粉红色、粉红色、浅肉红色、肉红色细粒–中粒–中粗粒二长花岗岩	235±2	
早古生代	泥盆纪	中泥盆世		ηD_2	二长岩–正长岩–石英二长岩建造	浅红色中粒二长岩	372 ~ 390	热液型金矿：钾化、黄铁矿化、硅化、绢云母化等
				ζD_2		肉红色中粗粒正长岩		
				$\eta o D_2$		灰白色、粉红色、浅肉红色细粒–中细粒–中粒石英二长岩		
				$\nu\eta D_2$	辉石角闪二长岩–辉石二长岩–角闪二长岩建造	灰白色、粉红色、浅肉红色细粒–中细粒–中粒–中粗粒辉石角闪二长岩		
				$\varphi\eta D_2$		灰白色细粒–中细粒–中粒辉石二长岩		
				$\psi\eta D_2$		肉红色细粒–中细粒–中粒角闪二长岩		
新太古代			晚期	$ggAr_3$	花岗片麻岩建造	花岗片麻岩		
中太古代			中期	$\eta\gamma Ar_2$	变质二长花岗岩类建造	变质二长花岗岩		热液型金矿：菱铁矿化、钾化等

同时，通过典型矿床研究，认为区内金矿可能经历了多期成矿事件的叠加 (Bao ZW et al.，2016；王大钊等，2020)，主成矿期的成矿地质体为燕山期侵入岩 (Bao ZW et al.，2014)，含矿建造为海西期水泉沟碱性杂岩体和谷嘴子岩组变质岩，成矿构造和结构面以 NNE 向压扭性和 NW 向张扭性构造为主 (郑亚东等，1990；李少众和靳光成，2000；蒋心明等，2000)，成矿作用特征标志表现为钾化、硅化、绢云母化等蚀变特征，矿床类型为中低温热液型金矿。本次制作的 1：50 000 矿产地质图数据库为该区的金矿找矿工作提供了基础数据支撑，能够更清晰地认识金矿的控矿因素，有利于对本区金矿目标层地质信息和构造建造信息的提取，如燕山期侵入岩和相关脉岩、海西期水泉沟碱性杂岩体和谷嘴子岩组、NNE 向压扭性成矿构造等。该数据库不仅是对找矿工作的理论探索，也是对矿产地质调查成果图面表达方式和内容的创新，对该区今后矿产勘查部署具有一定的参考价值。

表 6　火山岩建造一览表

岩石地层单位				建造单元特征					
系	统	群	组	代号	建造类型	厚度/m	岩性组合	矿化蚀变特征	锆石U–Pb同位素年龄/Ma
白垩系	下统	热河群	张家口组	K_1z^{3a}	石英安山玢岩建造	132.25	石英安山玢岩	陆相次火山岩型铅锌矿：绿帘石化、硅化、高岭土化	
				K_1z^{2e}	角砾熔岩建造	731.1	粗面质角砾熔岩、流纹质角砾熔岩		
				K_1z^{2d}	熔结凝灰岩–熔结凝灰角砾岩建造		熔结凝灰岩、流纹质熔结凝灰岩		
				K_1z^{2c}	安山岩–粗面岩建造		安山岩、粗面岩、粗安岩、粗面斑岩		127.8
				K_1z^{2b}	晶屑凝灰岩建造		晶屑凝灰岩、晶屑岩屑凝灰岩		
				K_1z^{2a}	集块岩建造		安山质集块岩		
				K_1z^{1a}	凝灰质沉积岩建造	549.5	凝灰质砂砾岩		

表 7　变质岩建造一览表

地质时代		岩石填图单位		建造单元特征			
代	纪	岩群	岩组	代号	建造类型	岩性组合	矿化蚀变特征
新太古代	晚期	红旗营子岩群	太平庄岩组	Ar_3t^c	黑云斜长变粒岩建造	黑云斜长变粒岩	
				Ar_3t^b	含石墨石榴子石黑云角闪糜棱岩–黑云角闪糜棱岩–长英质糜棱岩建造	含石墨石榴子石黑云角闪糜棱岩、含石墨黑云角闪糜棱岩、黑云角闪糜棱岩、长英质糜棱岩	区域变质石墨矿：绢云母化、白云母化；变质型磷灰石矿：磷灰石化、角闪石化
				Ar_3t^a	糜棱岩化二云石英片岩建造	糜棱岩化二云石英片岩、糜棱岩化二云片岩	
中太古代	中期	崇礼岩群	谷嘴子岩组	Ar_2g^c	角闪斜长变粒岩–混合岩化角闪斜长变粒岩建造	含石榴子石角闪斜长变粒岩、混合岩化角闪斜长变粒岩、斜长角闪变粒岩	
				Ar_2g^b	条纹、条带状黑云角闪斜长片麻岩建造	黑云角闪斜长片麻岩、黑云斜长片麻岩	
				Ar_2g^a	角闪透辉斜长变粒岩–混合岩化透辉斜长变粒岩建造	含石榴子石透辉角闪斜长变粒岩、混合岩化透辉斜长变粒岩、角闪透辉斜长变粒岩、辉石斜长变粒岩、透辉角闪变粒岩	沉积变质型铁矿：碳酸岩化、透闪石化；热液型金矿：钾化、黄铁矿化、硅化、绢云母化等

6 结论

(1) 全面系统编制了 1∶50 000 崇礼幅 (K50E019006) 矿产地质图，并建立了数据库，突出了对燕山期岩浆岩和相关脉岩、海西期碱性杂岩体和谷嘴子岩组、矿化蚀变等相关成矿信息的表达。

(2) 研究厘定出崇礼幅中太古代、新太古代的变质深成侵入体，划分了海西期、印支期、燕山期的岩浆岩建造类型，划分了张家口组火山岩的 7 个建造类型、谷嘴子岩组变质岩的 3 个建造类型，系统总结了该区金矿的成矿地质体、成矿构造及成矿结构面、成矿作用特征标志。

(3) 崇礼幅 1∶50 000 矿产地质图数据库为该区的金矿找矿工作提供了基础数据支撑，有利于对本区金矿目标层地质信息和构造建造信息的提取，对今后矿产勘查部署具有一定的参考价值。

致谢：河北省崇礼幅 1∶50 000 矿产地质图是一项集体成果，野外一线和室内制作人员都付出了辛勤的汗水。在矿产地质图数据库的建立过程中，得到叶天竺、王保良等多位专家的辛勤指导，在此对各位专家和项目组所有成员表示最诚挚的感谢。

注释：

❶ 甄世民，白海军，贾儒雅，姚磊，张志辉，陈辉，陶文，庞振山，程志中，薛建玲，左群超. 2019. 河北省宣化–丰宁矿集区找矿预测子项目成果报告 [R]. 北京: 中国地质调查局发展研究中心.

❷ 任树祥，宋立军，马奎羽，温延星，李彦华，李晓敏. 2013. 河北省矿产资源潜力评价成果报告 [R]. 石家庄: 河北省地质调查院.

❸ 河北省地质矿产局. 1989. 下两间房幅 K–50–111–A、崇礼幅 K–50–111–B、镇宁堡幅 K–50–111–A 1∶50 000 区域地质调查报告 [R]. 张家口: 河北省地矿局第三地质大队.

❹ 王银川，薄永祥，张鹍，杨秀录，白魁峰，张明达，李勇超，高嵩，孙家高，路叶. 2016. 河北省崇礼县东坪金矿区金矿资源储量核实报告 [R]. 张家口: 崇礼紫金矿业有限责任公司.

❺ 任树祥，宋立军，贾正海，温延星，李晓敏，马奎羽，董杰，宫进忠，郑国庆，张德生. 2011. 河北省金矿资源潜力评价成果报告 [R]. 石家庄: 河北省地质调查院.

参考文献

Bao Z W, Sun W D, Li C J, Zhao Z H. 2014. U–Pb dating of hydrothermal zircon from the Dongping gold deposit in North China: Constraints on the mineralization processes[J]. Ore Geology Reviews, 61: 107−119.

Bao Z W, Li C J, Zhao Z H. 2016. Metallogeny of the syenite–related Dongping gold deposit in the northern part of the North China Craton: A review and synthesis[J]. Ore Geology Reviews, 73: 198−210.

Cisse M, Lü X B, Algeo T J, Cao X F, Li H, Wei M, Yuan Q, Chen M. 2017. Geochronology and geochemical characteristics of the Dongping ore–bearing granite, North China: Sources and implications for its tectonic setting[J]. Ore Geology Reviews, 89: 1091−1106.

Jiang N, Liu Y S, Zhou W G, Yang J H, Zhang S Q. 2007. Derivation of Mesozoic adakitic magmas from ancient lower crust in the North China craton[J]. Geochimica et Cosmochimica Acta, 71(10): 2591−2608.

Mao J W, Li Y Q, Goldfarb R, He Y, Zaw K. 2003. Fluid inclusion and noble gas studies of the

Dongping gold deposit, Hebei Province, China: A mantle connection for mineralization?[J]. Economic Geology, 98(3): 517−534.

Miao L C, Qiu Y M, McNaughton N, Luo Z K, Groves D, Zhai Y S, Fan W M, Zhai M G, Guang K. 2002. SHRIMP U–Pb zircon geochronology of granitoids from Dongping area, Hebei Province, China: constraints on tectonic evolution and geodynamic setting for gold metallogeny[J]. Ore Geology Reviews, 19(3): 187−204.

Wang D Z, Zhen S M, Liu J J, Carranza E J M, Wang J, Zha Z J, Li Y S, Bai H J. 2020a. Mineral paragenesis and hydrothermal evolution of the Dabaiyang tellurium-gold deposit, Hebei Province, China: Constraints from fluid inclusions, H-O-He-Ar isotopes, and physicochemical conditions[J]. Ore Geology Reviews, https://doi.org/10.1016/j.oregeorev.2020.103904.

Wang D Z, Liu J J, Zhai D G, Fourestier J D, Wang Y H, Zhen S M, Wang J P, Liu Z J, Zhang F F. 2020b. Textures and formation of microporous gold in the Dongping gold deposit, Hebei Province, China[J]. Ore Geology Reviews, 120: 103437.

Wei H, Xu J H, Zhang G R, Cheng X H, Chu H X, Bian C J, Zhang Z Y. 2018. Hydrothermal metasomatism and gold mineralization of porphyritic granite in the Dongping deposit, North Hebei, China: Evidence from zircon dating[J]. Minerals, 8(9): 363.

Zhen S M, Wang Q F, Wang D Z, Carranza E J M, Liu J J, Pang Z S, Cheng Z Z, Xue J L, Wang J, Zha Z J. 2020a. Genesis of the Zhangquanzhuang gold deposit in the northern margin of North China Craton: Constraints from deposit geology and ore isotope geochemistry[J]. Ore Geology Reviews, 122: 103511.

Zhen S M, Wang D Z, Yu X F, Wang Q F, Li Y S, Zha Z J, Wang J. 2020b. Trace elements and sulfur isotopes of sulfides in the Zhangquanzhuang gold deposit, Hebei Province, China: Implications for physicochemical conditions and mineral deposition mechanisms[J]. Minerals, https://doi.org/10.3390/min10121089.

邓晋福, 冯艳芳, 刘翠, 肖庆辉, 苏尚国, 周肃, 高延光. 2009. 太行—燕辽地区燕山期造山过程、岩浆源区与成矿作用 [J]. 中国地质, 36(3): 623−633.

胡小蝶, 陈志宏, 赵彦明, 王魁元. 1997. 河北小营盘金矿成矿时代—单颗粒锆石 U–Pb 同位素年龄新证据 [J]. 前寒武纪研究进展, 20(2): 22–28.

蒋心明, 樊秉鸿, 李少众. 2000. 河北省东坪金矿矿田构造特征 [J]. 地质找矿论丛, 15(4): 351−356.

李少众, 靳光成. 2000. 东坪金矿床地质特征及构造控矿作用 [J]. 地球学报, 21(1): 44−51.

李长民, 邓晋福, 陈立辉, 苏尚国, 李惠民, 胡森林, 刘新秒. 2010. 华北北缘张宣地区东坪金矿中的两期锆石: 对成矿年龄的约束 [J]. 矿床地质, 29(2): 265−275.

罗镇宽, 苗来成, 关康. 2001. 河北张家口水泉沟岩体 SHRIMP 年代学研究及其意义 [J]. 地球化学, 30(2): 116−122.

宋国瑞, 赵振华. 1996. 河北省东坪碱性杂岩金矿地质 [M]. 北京: 地震出版社.

王大钊, 刘家军, 翟德高, 甄世民, 王江. 2020. 河北东坪碲金矿床辉钼矿 Re–Os 及锆石 U–Pb 年龄研究 [J]. 地学前缘, 27(2): 405−419.

叶天竺, 吕志成, 庞振山, 张德会, 王全明, 刘家军, 刘士毅, 程志中, 李超岭, 肖克炎, 甄世民, 杜泽忠, 陈正乐. 2014. 勘查区找矿预测理论与方法 (总论)[M]. 北京: 地质出版社, 230–245.

叶天竺, 韦昌山, 王玉往, 祝新友, 庞振山, 姚书振, 秦克章, 韩润生, 叶会寿, 孙景贵, 蔡煜琦, 甄世民, 薛建玲. 2017. 勘查区找矿预测理论与方法 (各论)[M]. 北京: 地质出版社, 234–525.

叶天竺, 张智勇, 肖庆辉, 潘桂棠, 冯艳芳. 2010. 成矿地质背景研究技术要求 [M]. 北京: 地质出版社.

银剑钊, 翟裕生. 1994. 张宣地区金矿成矿系列 [J]. 桂林工学院学报, 14(4): 359–369.

甄世民, 白海军, 缪建普, 贾儒雅, 姚磊. 2020. 河北省崇礼幅 1：50 000 矿产地质图数据库 [DB/OL]. (2020-12-30).DOI: 10.35080/data.C.2020.P25.

郑亚东, 宋官祥, 李广会, 张臣. 1990. 河北崇礼县东坪含金石英脉构造分析 [J]. 地质找矿论丛, 5(2): 20−28.

左群超, 黄旭钊, 杨东来, 张明华, 冯艳芳, 吴轩, 张德全, 于学政, 陈郑辉, 李景朝. 2012. 矿产资源潜力评价数据模型: 数据项下属词规定 [M]. 北京: 地质出版社.

左群超, 杨东来, 汪新庆. 2011. 成矿地质背景研究数据模型 [M]. 北京: 地质出版社.

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1∶50 000 Mineral Geological Map Database of the Chongli Map-sheet, Hebei Province, China

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Abstract: According to *Technical Requirement of Solid Mineral Geology Survey* (1∶50 000) (DD 2019–02) as well as other industrial criteria and requirements, 379.93 km^2 of 1∶50 000-scale geologic mapping of the Chongli Map-sheet, Hebei Province has been completed with 11 mineralized occurrences being verified, and 1 622 stream sediment samples being collected; 1 623 physical points of gravity survey were finished, three groups of zircon U–Pb dating samples and more than 80 pieces of fluid inclusion samples were tested, the 1∶50 000-scale geological map of Chongli Map-sheet, Hebei Province was compiled, and the correspondent database was established. Relevant mineralization information, including Yanshanian magmatic rocks and relevant dykes, alkaline complexes and Guzuizi Formation, mineralization and alteration, etc. were highlighted, Mesoarchean and Neoarchean metamorphogenic plutons within the Chongli Map-sheet area were delineated, and Hercynian, Indochina and Yanshanian magmatic rock formation types were divided; Zhangjiakou Formation volcanic rocks were divided into seven formation types, and Guzuizi Formation metamorphic rocks were divided into three formation types; the mineralized geologic bodies, mineralized structures and mineralized structural planes, mineralization characteristic indicators of gold deposits within the area were summarized systematically. This database provides basic data support for gold prospecting in the area, favors extracting geological and structure–formation information of

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target gold horizons and is of reference value to subsequent mineral exploration deployment.

Key words: 1∶50 000; mineral geological map; database; geological survey; Chongli Map-sheet; Hebei

Data service system URL: http://dcc.cgs.gov.cn

1 Introduction

The Chongli Map-sheet (K50E019006) lies about 30 km northeast of Zhangjiakou City, in the central segment of the northern margin of North China Craton (Fig. 1a[1]) and the western margin of the Yanshan Mountains. The area is endowed with abundant mineral resources and

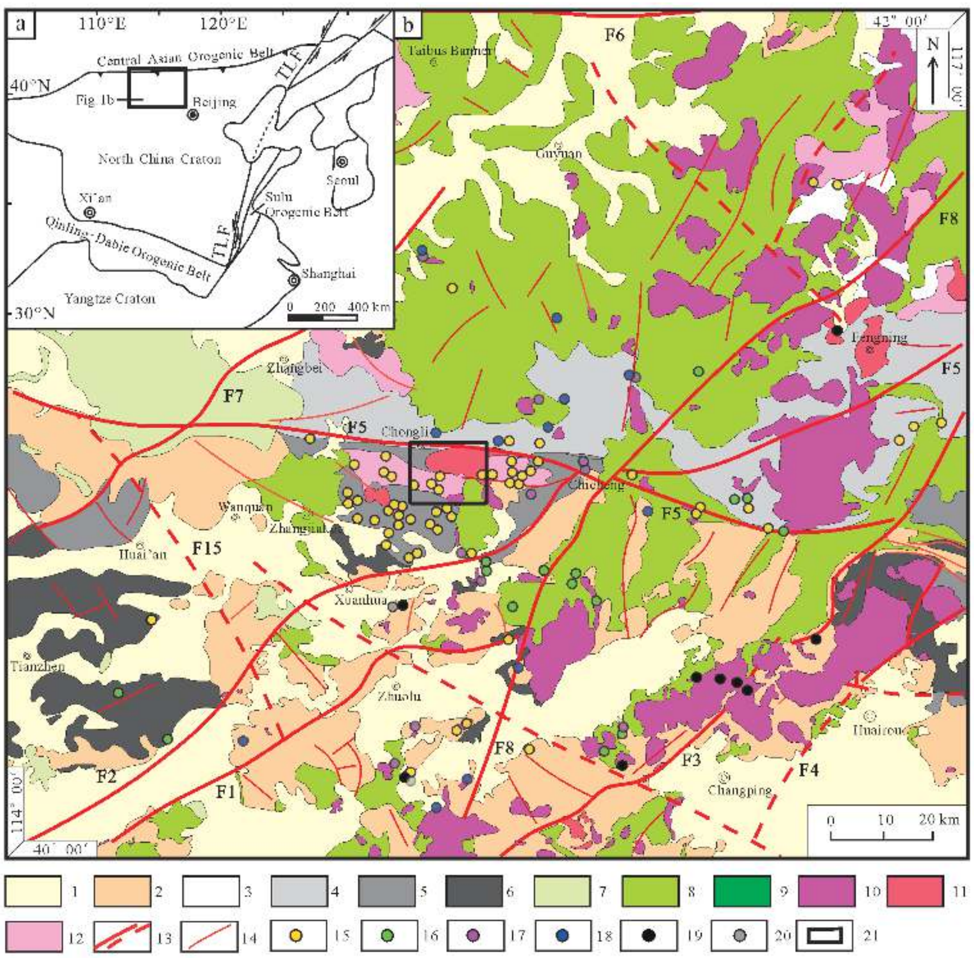

Fig. 1 Geological tectonic map (a) and regional geological map (b) of the Chongli Map-sheet, Hebei Province (modified from Zhen Shimin[1])

1—Quaternary; 2—Paleozoic–Mesozoic sedimentary rock series; 3—Paleoproterozoic metamorphic rock series; 4—Neoarchean metamorphic rock series; 5—Mesoarchean metamorphic rock series; 6—Paleoarchean metamorphic rock series; 7—Himalayan volcanic rock; 8—Yanshanian volcanic rock; 9—Indochina volcanic rock; 10—Yanshanian intrusive rock; 11—Indochina intrusive rock; 12—Hercynian intrusive rock; 13—Measured (inferred) deep-seated fault; 14—general fault; 15—gold deposit; 16—copper deposit; 17—silver deposit; 18—galena/zinc deposit; 19—molybdenum deposit; 20—tungsten deposit; 21—the scope of the study area; TLF—Tancheng–Lushan fault; F1—the southern margin deep-seated fault of the Sanggan–Pingquan structural (conjunction) belt; F2—the northern margin deep-seated fault of the Sanggan–Pingquan (conjunction) structural belt; F3—Zijingguan–Lingshan fault; F4—Taihangshan piedmont fault; F5—Shangyi–Chongli–Chicheng fault; F6—Kangbao–Weichang fault; F7—Zhangbei–Guyuan fault; F8—Shanghuangqi—Wulonggou fault; F15—Mashikou–Songzhiou fault is a significant constituent of the Taihang–Yanliao orogenic belt (Deng JF et al., 2009). Minerals within the area mainly include hydrothermal gold, parametamorphic iron, terrestrial subvolcanic rock-type galena/zinc, as well as non-metallic minerals such as phosphorus and graphite. More than 60 gold deposits have been discovered in the "Golden Triangle" at the junction of the Xuanhua–Chicheng–Chongli in the Zhangjiakou City, including two large-scale ones (Xiaoyingpan, Dongping), four medium-scale ones (Dabaiyang, Hougou, Zhang Quanzhuang, Huang Tuliang), and more than 20 small-scale ones. These gold deposits are directly or indirectly controlled by the middle Archean Guzuiziyan Formation and Hercynian Shuiquangou alkaline complex. On the basis of the geological and geochemistry characteristics of the deposits, the gold deposits in the area can be divided into three types, namely Dongping-type, Xiaoyingpan-type and Zhang Quanzhuang-type (Table 1).

Table 1 Types and characteristics of the gold deposits in northwestern Hebei

Characteristics of deposits	Dongping-type	Xiaoyingpan-type	Zhang Quanzhuang-type
Scale	Large-scale	Large-scale	Medium-scale
Ore-hosted rock	Alkaline complex	Plagioclase amphibolite (granulite, leptite, migmatite)	Plagioclase amphibolite, ultramafic rock
Type of ores (veins)	Mainly sulfide-poor quartz vein type, some altered rock type	Mainly sulfide-poor quartz vein type, some altered rock type	Sulfide-rich quartz vein type
Ore body shape, occurrence and scale	There are five main ore veins, hundreds to more than a thousand meters long, 0.24–5.10 meters thick, and 10–400 meters deep. The main veins dip to NW, with an dip angle of 30°–55°. The orebodies are vein-like, layered and lenticular. The ore-bearing veins single quartz vein and its upper and lower quartz complex veins, pinnate branch veins, as well as potassic alteration, silicification and potash monzanite	The main ore vein is 2 500–3 500 meters long along the strike, and 3 700 meters inclined deep, with 12 km^2 of distribution area. The ore body is controlled by a gently inclined quartz vein. The ore bodies mainly show layered, lentil-shaped and lenticular, with up to 21 meters thick	There are more than 50 gold-bearing quartz veins, with a length of 10–2 200 meters. The ore bodies are mainly lenticular. The main ore vein exhibits an average strike of 325°, an inclination to NE and an dip angle of 60°–80°. The ore body reoccurs after pinning, with a thick of 0.2–2 meters and a deep of more than 200 meters
Alteration of wall rock	Potash feldsparization, silicification, sericitization, epidotization, carbonation, baritization, kaolinization, ferritization, albitization	Potash feldsparization, silicification, carbonation, sericitization, chloritization, ferritization, albitization	Silicification, sericitization, chloritization, epidotization, carbonation, kaolinization
Main mineral association	Quartz, potash feldspar, plagioclase, hematite, specularite, limonite, pyrite, galena, chalcopyrite, native gold, calaverite, tetrahedrite, bornite, covellite, pyrrhotite	Quartz, potash feldspar, pyrite, galena, chalcopyrite, specularite, wulfenite, hematite, limonite, native gold, electrum, malachite, calaverite, aegentite, calcite	Quartz, potash feldspar, pyrite, galena, chalcopyrite,, ilmenite, native gold, electrum, ankerite, calcite

Continued table 1

Characteristics of deposits	Dongping-type	Xiaoyingpan-type	Zhang Quanzhuang-type
Ore textures	Disseminated, banded and marmorate structures; automorphic–subhedral granular metasomatic, emulsion and poikilitic textures	Vein and disseminated structures; automorphic–anhedral granular metasomatic relict, metasomatic pseudomorph and cataclastic textures	Vein, disseminated and lump structures; automorphic–anhedral granular, metasomatic relict, metasomatic pseudomorph, ablation and cataclastic textures
Gold grade(g/t)	Ranging from 3.2 to 571, with an average of 5–20	Ranging from 1.5 to 30 with an maximum of 154.05, and an average of 9.68	Mainly less than 30, with an maximum of 368.59, and an average of 14.3
Isotopic geochemistry characteristics	$\delta^{34}S$ has a range of variation; the ratio of $^{206}Pb/^{204}Pb$ is relatively high, falling on the Pb isotopic evolution line between the orogenic belt and the lower crust; $\delta^{18}O_{H2O}$ value has a wider distribution range than δD; the $^{40}Ar/^{36}Ar$ ratio is low	$\delta^{34}S$ is mainly negative with no positive values; the ration of $^{206}Pb/^{204}Pb$ is relatively low, mainly falling on the Pb isotopic evolution line between the mantle and lower crust; $\delta^{18}O_{H2O}$ value is high with a narrow variation range; the $^{40}Ar/^{36}Ar$ ratio is high	$\delta^{34}S$ value is positive near 0; the ratio of $^{206}Pb/^{204}Pb$is relatively low, mainly falling on the Pb isotopic evolution line between the mantle and lower crust; $\delta^{18}O_{H2O}$value is high with a wide variation range; the $^{40}Ar/^{36}Ar$ ratio is medium
Typical deposits	Dongping, Huangtuliang, Zhongshangou, Hougou, Zhaojiagou, Xiping, Yangmuwa	Xiaoyingpan, Dabaiyang, Shuijingtun, Heitugou, Ximawan	Zhangquanzhuang, Dayingpan, Xiangshuigou, Jinjiazhuang

Notes: modified from Wang DZ et al., 2020a; Zhen SM et al., 2020a, 2020b; Yin JZ and Zhai YS, 1994; Hu XD et al., 1997; Zhen Shimin[1].

Strata within the Zhangjiakou area mainly comprise Archean and Paleoproterozoic metamorphic series, Paleozoic–Mesozoic sedimentary series, and Jurassic–Cretaceous volcanic–sedimentary series. Among them, the Mesoarchean Guzuizi Formation is chiefly distributed south of the Shangyi–Chongli–Chicheng Fault, which is closely related to gold mineralization within the area in space (Fig.1b[1]). Within the area, tectonic activities are frequent and display long-term activity characteristics, and faults are extremely developed. Among them, the Shangyi–Chongli–Chicheng fault strikes EW, with a total length of 470 km, which is a significant rock/ore-controlled structure of the area; the Shanghuangqi–Wulonggou fault strikes NNE, with a total length of 250 km and has undergone a complicated evolution history; large-area Yanshanian granites and volcanic rocks are exposed in the periphery[2]. Within the area, fold structures are principally developed in the Paleoarchean Sanggan and Neoarchean Hongqiyingzi Groups. The axes of the folds mainly trend NW–SE, with pitched NW ends and elevated SW ends. Magmatic rocks are characterized by multi-phase, wide spreading and abundant rock types (Fig. 1b). In the Hercynian, Indochina and Yanshanian periods, magma intruded in the area, mainly forming intermediate-acid magmatic rocks. The Yanshanian tectonic–magmatic belt is generally controlled by the NNW-trending Shanghuangqi–Wulonggou, Zijingguan–Lingshan and Zhangbei–Guyuan fault belts (Fig. 1b) as well as by EW-trending basement and fault structures such as the Shangyi–Chongli–Chicheng fault belt.

The Chongli Map-sheet work area is part of the "Golden Triangle" at the Xuanhua–Chicheng–Chongli conjunction. In the work area, exploration has discovered large-scale Dongping gold deposit, small-scale Sandaogou galena/zinc deposit, and small-scale Yaoziwan iron deposit, etc. This survey focuses on the "Dongping-type" deposits. 1∶50 000-scale regional geologic and stream sediment surveys, etc. of the Chongli Map-sheet had been completed in the 1980s❸. However, a 1∶50 000-scale mineral geological survey has not been systematically conducted over the area, particularly mineralized geologic bodies, mineralized structures and surfaces, and mineralization characteristic indicators, etc. A poor summary of mineralization rules seriously constrains further prospecting and exploration on the area. In this 1∶50 000-scale mineral geological survey and study, regional mineralization geological conditions and mineral resource characteristics are generally identified, gold-controlling factors are analyzed, regional mineralization rules of gold deposits are revealed, regional gold resource potential is evaluated, the degree and level of mineral geologic survey and study of the area are enhanced, and the capability of mineral geological work serving resources safety, economic–social development and ecological civilization construction is enhanced.

2 Data Acquisition And Processing Methods

2.1 Data Basis

The 1∶50 000-scale mineral geological map of Chongli Map-sheet, Hebei Province was compiled through full utilization use of the 1∶250 000 and 1∶200 000-scale regional geological survey results under the guidance of "trinity" ore prospecting prediction theory of exploration areas (Ye et al., 2014, 2017), with *Technical Requirement of Solid Mineral Geology Survey* (1∶50 000) (DD 2019–02) as the basic requirement, and based on the original data (including primitive data maps, profiles and records) of 1∶50 000-scale regional geological survey❸ and mineral resource potential evaluation of Hebei Province. The geographic information base map adopted National 2000 Geodetic Coordinate System (CGCS2000). Data processing was performed by existing technical standards and digital mapping system (DGSS) and MapGIS. The geological mapping and study results were integrated in full.

The metadata of the 1∶50 000-scale mineral geological map database of Chongli Map-sheet, Hebei Province (Zhen SM et al., 2020c) was in line with *Geological Information Metadata Standards* (DD2006–05). The simplified table is shown in Table 2.

To compile the 1∶50 000-scale mineral geological map of Chongli Map-sheet, about 870 km❸ and 145 lines of 1∶50 000-scale regional geological survey routes were collected and revised, and 14 groups of zircon U–Pb age data and 30 groups of whole-rock analysis data were adopted from previous data. In this work, 300 km of geological routes was measured, 11 ore occurrences were checked, and three groups of zircon U–Pb ages were dated (Table 3), more than 500 photos were taken, and more than 80 fluid inclusion samples were collected,

Table 2 Metadata Table of the Database (Dataset)

Item	Description
Database(dataset) name	1：50 000 Mineral Geological Map Database of the Chongli Map-sheet, Hebei Province, China
Database(dataset) authors	Zheng Shimin, Development and Research Center of China Geological Survey Bai Haijun, No. 3 Geological Brigade of Hebei Geology and Mineral Exploration Bureau Miao Jianpu, No. 3 Geological Brigade of Hebei Geology and Mineral Exploration Bureau Jia Ruya, Development and Research Center of China Geological Survey Yao Lei, Development and Research Center of China Geological Survey
Data acquisition time	From 2016 to 2018
Geographic area	115°15′–115°30′E, 40°50′–41°00′N
Data format	MapGIS
Data size	15. 7 MB
Data service system URL	http://dcc.cgs.gov.cn
Fund project	Funded by China Geological Survey project entitiled “Prospecting in the significant ore cluster across China” (DD20160052)
Language	Chinese
Database(dataset) composition	The 1：50 000-scale mineral geological map database of the Chongli Map-sheet includes 1：50 000 geological map library and graphic decoration. The map library includes sedimentary rocks, magmatic rocks, volcanic rocks, metamorphic rocks, Quaternary, dykes, structures, geologic boundaries, attitude, mineral deposits (occurrences), alternation, lithologic textures and codes, etc. The graphic decoration includes index map, columns, legends, cutting profiles, distribution plans of ore vein clusters of typical mineral deposits, sections of typical mineral deposits, lists of mineral deposits, geotectonic position, duty table, etc.

Table 3 List of zircon U–Pb ages of magmatic rocks within the Chongli Map-sheet area

Number	Sample description	U–Pb age/Ma	References
1	Shuiquantou monzonite complex	390±6	Luo ZK et al., 2001
2	Hydrothermal zircons from Au-bearing quartz veins, Dongping gold deposit	380.5±2.6	Li CM et al., 2010
3	Honghualiang monzonite	235±2	Jiang N et al., 2007
4	Shangshuiquanzi biotite granite	142.2±1.3	Miao LC et al., 2002
5	Porphyritic granite from Dongping gold deposit	142.06±0.84	Wei H et al., 2018
5	Zhuanzhilian pyroxene diorite	139±0.9	Jiang N et al., 2007
6	Rhyolite in the Zhangjia Formation	135±2	This work
7	Beizhazi biotite monzonite	130±2	This work
8	Ivernite	125.9±2.2	This work

etc. Besides, previous research outcomes about mineral exploration[4] and typical mineral deposits of the area were fully used (Song GR and Zhao ZH, 1996; Mao JW et al., 2003; Cisse et al., 2017; Wang DZ et al., 2020b).

2.2 Data Processing

2.2.1 Data Preparation

1 ∶ 50 000-scale regional geological survey results and primitive data maps collected were digitized, forming MapGIS point, line and polygon files. According to the scope, a 1 ∶ 50 000-scale standard map frame was generated for the Chongli Map-sheet, the projection system was Gauss–Kruger Projection, and the coordinate system was CGCS2000.

2.2.2 Compilation of the Suite-Tectonic Draft Maps

By finding and analyzing the primitive data, including measured sections and field geological records, etc. involved in the 1 ∶ 50 000 scale regional geological survey report[3], the first-class mapping units, which were formations, were determined, lithologic (combination) boundaries were supplemented, and field records were expressed on the primitive data map in the form of lithologic formation pattern points or lines.

(1)Suites

As per a uniform color standard, polygon elements of variable colors mark the time of suites, suite patterns mark suite types, and correspondent patterns mark lithologic assemblages, coded as “lithology+time”, e.g., the Hercynian Shuiquangou alkaline complex was divided into six lithologic assemblages by color, mineral composition and mineral grain size, etc., and their suite implications were expressed by correspondent patterns and colors.

(2)Dykes

As per a uniform color standard, the color of polygon elements marks lithology and lithology codes are adopted.

(3)Structures

As per a uniform color standard, structures were expressed in red, and different line types represent fault properties.

(4)Geologic sections

“Standard section line type+section code” marks the location and geologic points and codes represent the actual control points, correspondent patterns mark the lithologies of variable horizons, and attitude is expressed on geological sections.

(5)Petrochemical, geochemical and isotope sampling points

”Standard subgraph number+sample code” marks the sampling location and a database is established.

2.2.3 Field Special Geological Mapping

According to the comprehensive analysis of existing data and suite–tectonic draft map, key and minor survey areas were divided, the key contents for special geologic mapping were determined to be Yanshanian intrusive rocks, mineralization alteration, structures, intermediate-acid dykes, etc. With the 1 ∶ 25 000-scale primitive data map in digital mapping pocket PC as the base map, by field route survey, the point and line information on geological points, boundary points and geological boundaries and routes, etc. were marked on the digital mapping system, and properties, lithologies and attitude of various points were observed and input, and the primary digital mapping (PRB) database was established.

Geopoint (P): including boundary point and observation point. Simple attributes were populated in the system in the field, including point No., point attribute, microrelief, outcrop, weathering degree, location description, mapping unit and contact relationship; coordinate information were read automatically by the digital mapping system.

Geological route (R): route no., geological point no., azimuthal angle, distance of current workstation, cumulative distance, mapping unit and rock name were populated in the digital mapping system in the field. The system automatically calculates azimuthal angle, distance of current workstation and accumulative distance.

Geological boundary (B): route no., geological point no., boundary code, route code, boundary type, the left mapping unit, the right mapping unit, contact relationship, striking, dipping and dip angle were populated in the digital mapping system in the field.

Relevant information including geologic attitude and collected samples, etc. observable on the way was input in the digital mapping system with orientation at any time. Attribute data were also input.

2.2.4 Indoor Data Processing

(1) Geopoint (P), geological route (R) and geological boundary (B) data collected in the field were imported into the computer, and data processing was implemented as per correspondent criteria.

(i) Flowsheet and basic requirements of Geopoint (P) data processing: route no., weathering degree, and contact relationship, etc. were completely filled as per the actual condition, correspondent mapping codes were filled for mapping units, rock name was consistent with that in geological description dialog box (including color, texture and structure, etc.), noted with thin section identification results, and filling was performed after comprehensive naming as per the actual condition.

(ii) Data processing flowsheet and basic requirements for Geological route (R): data processing was performed as per “smooth curve → modify line parameters (line property 1, color 1 and line width 0) → inter-point route calculation → (statistics of workload)”, etc. R-attribute database was supplemented, and azimuth and distance were re-calculated before geological route description.

(iii) Data processing flowsheet and basic requirements for Geological boundary (B): geological boundaries were beautified as per contact relationship using cut short line, extend line or re-draw line on indoor computer. Color, line attribute, and line width, etc. were unified, that “the left is ×××, and the right is ×××” marks lithologies on sides, and the default left is the first-observed lithology and the right is the second-observable lithology, and the contact relationship and evidence of two lithologies were described.

(iv) Basic requirements for attitude, sampling and photos in routes: descriptive information including attitude and sampling etc. of correspondent attributes were supplemented. Attitude was numbered as 1, 2 and 3, etc. after Geopoint transformation and photos were imported as per requirements and then photographic contents and geological information that photos reflect were described in Detailed Photo Description.

(2) Primitive data map dominated by PRB data collected in the field and primitive data map of regional geological survey summarized in compiling the formation–structure sketch were combined, and stratigraphic unit boundaries, formation textures and structural shapes reflecting various formations were revised, and the new boundaries of geological units were connected.

2.2.5 Compilation of Various Auxiliary Drawings

(1) Suite columns. The suite characteristics of the lithostratigraphic units in the master map were expressed in detail. Relationships of various formations with structures and mineralization within the map-sheet were analyzed comprehensively, and sedimentary, volcanic, intrusive and metamorphic suite columns were compiled.

(2) Auxiliary drawings of typical deposits. On the basis of previous research outcomes and taking full use of field survey and comprehensive research of typical deposits, the auxiliary drawings of typical deposits were compiled, including the distribution maps of gold vein clusters (zones) of Dongping gold deposit, planar sketches of main ore bodies, and No.7 exploration line sections, etc.

(3) Cutting profiles. The suites and structures within the Map-sheet generally strike NWW, EW and NNE. In order to effectively reflect the general suite and structure characteristics and the relation with mineralization within the map-sheet, two cutting profiles striking NS and NW were laid out across the whole so as to respectively control Mesoarchean metamorphic rocks, Middle Devonian monzonites, Late Triassic monzonites, Early Cretaceous granite and volcanic rocks. The "Standard section linetype+standard code" marks the location, and geopoint with code marks the condition of actual control points. The correspondent pattern marks the lithology of individual horizons, and attitude is shown in geological profiles.

(4) List of mineral deposits. The mineral deposits within the area were analyzed as per mineral deposit name, scale, type and main ore-bearing formation, etc. and the list of mineral deposits was compiled.

(5) Geotectonic location map. The map shows the regional tectonic location of the Chongli Map-sheet. On the basis of data collection of mineral resource potential evaluation throughout China and Hebei Province[❷❺], the region outline was determined and the map was cut according to the map-sheet location, and I–IV geotectonic units, main geographic names and gold deposits were remained and then the map was zoomed, generating an auxiliary map of the geotectonic location of the Chongli Map-sheet.

(6) Other auxiliary drawings. The dykes, structures and mineralization alteration legends were summarized and various legends were compiled.

3 Data Content Description

3.1 Data Naming Mode

The data naming mode from MapGIS was adopted, i.e., geological polygon.wp, geological line.wl, and geopoint.wt.

3.2 Layer Contents

The master map mainly contains sedimentary, volcanic, intrusive and metamorphic suites, structures, geological boundaries, attitude, mineral deposit, mineralization alteration, various codes, and geographic information, etc.

The auxiliary drawings mainly contain index map, suite columns, legends, cutting profiles, distribution maps of ore vein clusters (zones) of typical deposits, exploration line profiles of typical deposits, list of mineral deposit, geotectonic location map, and duty table, etc.

3.3 Data types

Entity type name: point, line and polygon.

Point entity: codes and marks of various geological bodies, geological texture, mineral deposit, and mineralization alteration.

Line entity: fault structure, geological boundary, lithofacies boundary, etc.

Polygon entity: sedimentary rock, volcanic rock, metamorphic rock, intrusive rock, the Quaternary and dykes, etc.

3.4 Data Attributes

The 1∶50 000-scale mineral geological map database of the Chongli Map-sheet contains geological entity elements, geographic elements and geological map decorations, etc. Geographic element attributes continue to adopt the attribute structure of data collected by the National Bureau of Surveying and Mapping of China. For geological entity element attributes, as per the requirements for 1∶50 000-scale mineral geological survey database establishment, the database attributes were established separately for four categories of rocks (namely, sedimentary rock, volcanic rock, intrusive rock and metamorphic rock), fault structures, attitude elements and mineral deposits, etc. (Table 4). The database attributes followed *Technical Requirements for Metallogenic Geological Setting Research* (Ye TZ et al., 2010), *Data Model of Metallogenic Geological Setting Research* (Zuo QC, 2011), *Data Model of Mineral Resource Potential Evaluation*: *Rules for Subordinate Words of Data Items* (Zuo QC, 2012).

4 Data Quality Control and Monitor

This survey was performed in strict accordance with *Instructions For* 1∶50 000 *Mineral Geologic Survey* (*pilot edition*) issued by China Geological Survey in 2016 and *Technical Requirement of Solid Mineral Geological Survey* (1∶50 000)(DD 2019–02). The method of combined mapping and compilation was employed for mapping Chongli Map-sheet, the key survey area was mainly based on measured data, the minor survey areas were mainly according to the raw materials of 1∶50 000 *Regional Geological Survey Report of Xialiangjianfang Map-sheet K–50–111–A*, *Chongli Map-sheet K–50–111–B and Zhenningpu Map-sheet K–50–111–A*[3]. Geopoint density was determined according to the principles of completely controlling mineralization-related geological bodies, mineralization alteration zones,

Table 4 List of data attributes of the mineral geological map of the Chongli Map-sheet

No.	Data item	Data attributes
1	Sedimentary suite	Chronostratigraphic unit, lithostratigraphic unit, suite name, suite code, lithologic assemblage, stratigraphic age, suite thickness, ore-bearing potential of suite, rock texture, sedimentary structure, rock color, sedimentation type, sedimentary facies type, synsedimentary structure, etc.
2	Volcanic suite	Chronostratigraphic unit, lithostratigraphic unit, suite name, suite code, lithologic assemblage, stratigraphic age, stratigraphic regionalization, lithologic assemblage, suite thickness, ore-bearing potential of suite, volcano eruption cycle, volcano eruption type, volcanic genesis type, special lithologic interlayer, volcanic facies type, isotope age, etc.
3	Intrusive suite	Suite name, suite code, lithologic assemblage, ore-bearing potential of suite, rock texture, rock structure, intrusion phase, intrusion attitude, planar shape, section configuration, intrusion emplacement structure characteristics, contact characteristics, genesis type, isotope age, etc.
4	Metamorphic suite	Chronostratigraphic unit, lithostratigraphic unit, suite name, suite code, lithologic assemblage, stratigraphic age, suite thickness, ore-bearing potential of suite, rock texture, rock structure, protolith suite, metamorphic facies, metamorphism, etc.
5	Fault structure	Fault name, fault type, fault length, fault depth, fault width, fault striking, fault surface dip and dip angle, fault displacement, fault surface morphology, tectonite characteristics, movement mode, activation phase, mechanical property, etc.
6	Attitude	Attitude type, dip, dip angle, etc.
7	Mineral deposit	Mineral deposit no., mineral deposit name, mineral deposit type, geographic longitude, geohraphic latitude, mineral species, deposit origin type, scale, symbiotic (associated) mineral, identified resource, etc.

significant geological boundaries, etc. The map generally shows closed geological bodies with diameters of more than 100 m, linear geological bodies with widths of more than 50 m and lengths of more than 250 m, as well as fault and fold structures with lengths of more than 250 m. Mineralized alteration structural zones and other mineralization geological bodies, regardless of their sizes, are all shown on the map; thin geological bodies were amplified or combined using appropriate textures and symbols. The error between the position of geopoints marked on the map of field free-hand work and the actual position should be no larger than 25 m. The work accuracy of the survey area reaches the requirements for 1：50 000-scale.

During project field work, the "three-level quality check system" was rigorously implemented in line with *Management Measures for Geological Survey Projects* issued by China Geological Survey in 2011. The percentages of self-check and mutual check of raw materials were both 100%, the percentage of check of the project team was above 50%, and the percentage of spot check of the quality testing team exceeded 15%, which ensures the data quality. Sample test and analysis was all completed at the qualified laboratories, internal and external monitoring was conducted during analysis process, and the analysis quality meets with requirements.

5 Data Value

The 1：50 000-scale mineral geological map of the Chongli Map-sheet, Hebei Province (K50E019006) is one case map-sheet of China Geological Survey in the new round of mineral geological survey. According to *Technical Requirement of Solid Mineral Geological Survey* (1：50 000)(DD 2019–02), on the basis of in-depth study of suite–tectonics within the map-sheet, and combined with this 1：50 000 special geological mapping results, comprehensive research was performed across the survey process, highlighting the geological bodies related to medium or low temperature hydrothermal gold mineralization. Zircon U–Pb ages of various phases of intrusions were collected and supplemented, Mesoarchean and Neoarchean metamorphic plutons within the Map-sheet area were identified, six suite types of Hercynian Shuiquangou alkaline complexes and one suite type of the Indochina Honghualiang intrusion were identified; three suite types, i.e., Shangshuiquan intrusion bitotite granite, Zhuanzhilian intrusion pyroxene diorite and Beizhazi intrusion biotite monzonite of Yanshanian period were classified (Table 5); diagenetic lineage was established for magmatic rocks; seven suite types were recognized from the volcanic rocks in Zhangjiakou Formation (Table 6); metamorphic strata were re-divided, and the Guzuizi and Taipingzhuang Formations were divided separately into three suite types (Table 7).

In addition, research into typical deposits indicates that the gold deposits within the area may have undergone superimposition of multi-phased metallogenic events (Bao ZW et al., 2016; Wang DZ et al., 2020c), ore-forming geological bodies of the main metallogenic phase are Yanshanian intrusive rocks (Bao ZW et al., 2014), the ore-bearing formation is the Hercynian Shuiquangou alkaline complex and Guzuizi Formation metamorphic rocks, the ore-forming structures and structural planes are dominated by NW-trending tenso-shear structures and NNE-trending compresso-shear structural planes (Zheng YD et al., 1990; Li SZ and Jin GC, 2000; Jiang XM et al., 2000), mineralization characteristic indicators show potassic alteration, silification and sericitization, etc., and the deposit type is of low to medium temperature hydrothermal gold mineralization. The 1：50 000-scale mineral geological map database provides basic data support for gold prospecting of the area, makes gold controlling factors more clearly understood, and favors extracting geological and tectonic-suite information of gold target horizons of the area, e.g., Yanshanian intrusive rocks and relevant dykes, Hercynian Shuiquangou alkaline complex and Guzuizi Formation, NNE-trending compresso-shear ore-forming structures, etc. The database is not only a prospecting theoretical exploration, but also an innovation in expression modes and contents of mineral geological outcome maps. It is of certain reference value to subsequent mineral exploration deployment.

6 Conclusions

(1)The 1：50 000-scale mineral geological map of the Chongli Map-sheet ((K50E019006) is systematically compiled, and the correspondent database is established, highlighting the expression of relevant mineralization information including Yanshanian magmatic rocks and relevant dykes, Hercynian alkaline complexes and Guzuizi Formation, as well as alteration, etc.

(2)Mesoarchean and Neoarchean metamorphic plutons of the Chongli Map-sheet are defined, which are divided into Hercynian, Indochina and Yanshanian magmatic suite types. The volcanic rocks in the Zhangjiakou Formation are divided into seven suite types, and the

Table 5 List of intrusive rock suites

Time				Suite characteristics				
Era	Period	Epoch	Age	Code	Suite type	Lithologic assemblage	Zircon U–Pb isotope age/Ma	Mineralization alteration
Mesozoic	Cretaceous	Early Cretaceous		$\eta\gamma\beta K_1$	Biotite monzonitic granite suite	Grayish-white medium-fine grained biotite monzonitic granite	130.5	
				$\varphi\delta K_1$	Pyroxene diorite suite	Dark gray medium-fine–medium grained pyroxene diorite	139.5±0.9	
				$\gamma\beta K_1$	Biotite granite suite	Shallow flesh pink medium–medium to coarse grained biotite granite	142	
	Triassic	Late Triassic		$\eta\gamma T_3$	Monzonitic granite suite	Grayish white, shallow pink red, pink red, shallow flesh pink, flesh pink fine–medium–medium to coarse grained monzonitic granite	235±2	
Early Paleozoic	Devonian	Middle Devonian		ηD_2	Monzonite–syenite–quartz monzonite suite	Shallow red medium-grained monzonite	372–390	Hydrothermal gold deposit: potassic alteration, pyritization, silification and sericitization, etc.
				ξD_2		Flesh pink medium to coarse grained syenite		
				$\eta o D_2$		Grayish white, pink red, shallow flesh pink fine–medium to fine–medium grained quartz monzonite		
				$\nu\eta D_2$	Pyroxene-hornblende monzonite–pyroxene monzonite–hornblende monzonite suite	Grayish white, pink red, shallow flesh pink fine–medium to fine–medium –medium to coarse grained pyroxene-hornblende monzonite		
				$\varphi\eta D_2$		Grayish white fine–medium to fine–medium grained pyroxene monzonite		
				$\psi\eta D_2$		Flesh pink fine–medium to fine–medium grained hornblende monzonite		
Neoarchean			Late Neoarchean	$ggAr_3$	Granitic gneiss suite	Granitic gneiss		

Continued table 5

Time				Suite characteristics				
Era	Period	Epoch	Age	Code	Suite type	Lithologic assemblage	Zircon U–Pb isotope age/Ma	Mineralization alteration
Mesoarchean			Middle Mesoarchean	$\eta\gamma Ar_2$	Metamorphic monzonitic granite suite	Metamorphic monzonitic granite		Hydrothermal gold deposit: sideritization potassic alteration, etc.

Table 6 List of volcanic rock suites

Lithostratigraphic unit				Suite characteristics					
System	Series	Group	Formation	Code	Suite type	Thickness/m	Lithologic assemblage	Mineralization alteration	Zircon U–Pb isotope age /Ma
Cretaceous	Lower	Rhee Group	Zhangjiakou Fm.	K_1z^{3a}	Quartz andesitic porphyrite suite	132.25	Quartz andesitic porphyrite	Terrestrial subvolcanic galena–zinc mineralization: epidotization, silification, kaolinitization	
				K_1z^{2e}	Breccia lava suite	731.1	Trachytic breccia lava, rhyolitic breccia lava		
				K_1z^{2d}	Welded tuff–welded tuffaceous breccia suite		Welded tuff, rhyolitic welded tuff		
				K_1z^{2c}	Andesite–trachyte suite		Andesite, trachyte, trachyandesite, trachyte porphyry		127.8
				K_1z^{2b}	Crystal tuff suite		Crystal tuff, crystallithic tuff		
				K_1z^{2a}	Agglomerate suite		Andesitic agglomerate		
				K_1z^{1a}	Tuffaceous sedimentary suite	549.5	Tuffaceous sandy conglomerate		

Table 7 List of metamorphic rock suites

Geologic time		Rock mapping unit		Suite characteristics			
Era	Period	Group	Formation	Code	Suite type	Lithologic assemblage	Mineralization alteration
Neoarchean	Late Neoarchean	Hongqiyingzi Group	Taipingzhuang Formation	Ar_3t^c	Biotite-plagioclase leptite suite	Biotite-plagioclase leptite	
				Ar_3t^b	Graphite-bearing garnet-biotite-honrblende mylonite–biotite-honrblende mylonite–felsic mylonite suite	Graphite-bearing garnet-biotite-hornblende mylonite, graphite-bearing biotite-hornblende mylonite, biotite-hornblende mylonite, felsic mylonite	Regional metamorphic graphite deposit: sericitization; metamorphic apatite deposit: apatite alteration and amphibolization
				Ar_3t^a	Mylonitized two-mica quartz schist suite	Mylonitized two-mica quartz schist, mylonitized two-mica schist	
Mesoarchean	Middle Mesoarchean	Chongli Group	Guzuizi Formation	Ar_2g^c	Hornblende-plagioclase leptite–migmatized hornblende-plagioclase leptite suite	Garnet-bearing hornblende–plagioclase leptite, migmatized hornblende-plagioclase leptite, plagioclase–hornblende leptite	
				Ar_2g^b	Striped and banded biotite-hornblende-plagioclase gneiss suite	Biotite-hornblende-plagioclase gneiss, biotite-plagioclase gneiss	
				Ar_2g^a	Hornblende-diopside-plagioclase leptite–migmatized diopside-plagioclase leptite formation	Garnet-bearing diopside-hornblende-plagioclase leptite, migmatized diopside-plagioclase leptite, hornblende-diopside-plagioclase leptite, pyroxene-plagioclase leptite, diopside-hornblende leptite	Metamorphic sedimentary iron deposit: carbonatization and tremolitization; hydrothermal gold deposit: potassic alteration, pyritization, silification and sericitization, etc.

metamorphic rocks in the Guzuizi Formation are divided into three suite types. The gold metallogenic geological bodies, metallogenic structures and structural planes, as well as mineralization characteristic indicators of the area are systematically summarized.

(3)The 1：50 000-scale mineral geological map database of the Chongli Map-sheet provides basic data support for gold prospecting of the area, favors extracting geological and tectonic–suite information of target gold horizons of the area, and is of certain reference value to subsequent mineral exploration deployment.

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Notes:

❶ Zhen Shimin, Bai Haijun, Jia Ruya, Yao Lei, Zhang Zhihui, Chen Hei, Tao Wen, Pang Zhenshan, Cheng Zhizhong, Xue Jianling, Zuo Qunchao. 2019. Prospecting of Xuanhua–Fengning Ore Cluster Area, Hebei Province[R]. Beijing: Development and Research Center, China Geological Survey.

❷ Ren Shuixiang, Song Lijun, Ma Kuiyu, Wen Yanxing, Li Yanhua, Li Xiaomin. 2013. Report on Mineral Resource Potential Evaluation of Hebei Province[R]. Shijiazhuang: Hebei Institute of Geological Survey.

❸ Hebei Geology and Mineral Exploration Bureau. 1989. 1：50 000-scale Regional Geological Survey Report of Xialiangjianfang Map-Sheet K–50–111–A, Chongli Map-Sheet K–50–111–B and Zhenningbao Map-Sheet K–50–111–A [R]. Shijiazhuang: No. 3 Geological Brigade of Hebei Geology and Mineral Exploration Bureau.

❹ Wang Yinchuan, Bo Yongxiang, Zhang Kun, Yang Xiulu, Bai Kuifeng, Zhang Mingda, Li Yongchao, Gao Song, Sun Jiagao, Lu Ye. 2016. Gold Resource Reserve Verification Report of Dongping Gold Deposit, Chongli County, Hebei Province[R]. Zhangjiakou: Chongli Zijin Mining Co., Ltd.

❺ Ren Shuxiang, Song Lijun, Jia Zhenghai, Wen Yanxing, Li Xiaomin, Ma Kuiyu, Dong Jie, Gong Jinzhong, Zheng Guoqing, Zhang Desheng. 2011. Report on Mineral Resource Potential Evaluation of Hebei Province[R]. Shijiazhuang: Hebei Institute of Geological Survey.

References

Bao Z W, Sun W D, Li C J, Zhao Z H. 2014. U–Pb dating of hydrothermal zircon from the Dongping gold deposit in North China: Constraints on the mineralization processes[J]. Ore Geology Reviews, 61: 107−119.

Bao Z W, Li C J, Zhao Z H. 2016. Metallogeny of the syenite–related Dongping gold deposit in the northern part of the North China Craton: A review and synthesis[J]. Ore Geology Reviews, 73: 198−210.

Cisse M, Lü X B, Algeo T J, Cao X F, Li H, Wei M, Yuan Q, Chen M. 2017. Geochronology and geochemical characteristics of the Dongping ore–bearing granite, North China: Sources and implications for its tectonic setting[J]. Ore Geology Reviews, 89: 1091−1106.

Deng Jinfu, Feng Yanfang, Liu Cui, Xiao Qinghui, Su Shangguo, Zhou Su, Gao Yanguang. 2009. Yanshanian (Jurassic—Cretaceous) orogenic processes, magma sources and metallogenesis as well as coal formation in the Taihangshan–Yanshan–West Liaoning region[J]. Geology in China, 36(3): 623−633 (in Chinese with English abstract).

Hu Xiaodie, Chen Zhihong, Zhao Yanming, Wang Kuiyuan. 1997. The metallogenetic epoch of the Xiaoyingpan gold deposit——the new amterial of U–Pb isotopic age on single zircon[J]. Progress in Precambrian Research, 20(2): 22−28 (in Chinese with English abstract).

Jiang N, Liu Y S, Zhou W G, Yang J H, Zhang S Q. 2007. Derivation of Mesozoic adakitic magmas from ancient lower crust in the North China craton[J]. Geochimica et Cosmochimica Acta, 71(10): 2591−2608.

Jiang Xinming, Fan Binghong, Li Shaozhong. 2000. Gold ore controlling structure in Dongping gold ore field, Chongli County, Hebei Province, China[J]. Contributions to Geology and Mineral Resources Research, 15(4): 351−356 (in Chinese with English abstract).

Li Changmin, Deng Jinfu, Chen Lihui, Su Shangguo, Li Huimin, Hu Linlin, Liu Xinmiao. 2010. Two periods of zircon from Dongping gold deposit in Zhangjiakou–Xuanhua area, northern margin of North China: Constraints on metallogenic chronology[J]. Mineral Deposits, 29(2): 265−275 (in Chinese with English abstract).

Li Shaozhong, Jin Guangcheng. 2000. Geological characteristics and structural ore–controlling role of the Dongping gold deposit, Hebei Province[J]. Acta Geoscientia Sinica (Bulletin of the Chinese Academy of Geological Sciences), 21(1): 44−51 (in Chinese with English abstract).

Luo Zhenkuang, Miao Laicheng, Guan Kang, Qiu Youshou, Y.M.Qiu, N.J.McNaughton, D.I.Groves 2001. SHRIMP chronological study of Shuiquangou intrusive body in Zhanjiakou Area, Hebei Province and its geochemical significance[J]. Geochimica, 30(2): 116−122 (in Chinese with English abstract).

Mao J W, Li Y Q, Goldfarb R, He Y, Zaw K. 2003. Fluid inclusion and noble gas studies of the Dongping gold deposit, Hebei Province, China: A mantle connection for mineralization?[J]. Economic Geology, 98(3): 517−534.

Miao L C, Qiu Y M, McNaughton N, Luo Z K, Groves D, Zhai Y S, Fan W M, Zhai M G, Guang K. 2002. SHRIMP U–Pb zircon geochronology of granitoids from Dongping area, Hebei Province, China: constraints on tectonic evolution and geodynamic setting for gold metallogeny[J]. Ore Geology Reviews, 19(3): 187−204.

Song Guorui, Zhao Zhenhua. 1996. Geology of Dongping alkaline complex–hosted gold deposit in Hebei Province[M]. Beijing: Seismological Press (in Chinese).

Wang D Z, Zhen S M, Liu J J, Carranza E J M, Wang J, Zha Z J, Li Y S, Bai H J. 2020a. Mineral paragenesis and hydrothermal evolution of the Dabaiyang tellurium-gold deposit, Hebei Province, China: Constraints from fluid inclusions, H-O-He-Ar isotopes, and physicochemical conditions[J]. Ore Geology Reviews, https://doi.org/10.1016/j.oregeorev.2020.103904.

Wang D Z, Liu J J, Zhai D G, Fourestier J D, Wang Y H, Zhen S M, Wang J P, Liu Z J, Zhang F

Forestier. 2020b. Textures and formation of microporous gold in the Dongping gold deposit, Hebei Province, China[J]. Ore Geology Reviews, 120: 103437.

Wang Dazhao, Liu Jiajun, Zhai Degao, Zhen Shimin, Wang Jiang. 2020c. Study on molybdenite Re–Os and zircon U–Pb ages of the Dongping tellurium–gold deposit in Hebei Province[J]. Earth Science Frontiers, 27(2): 405−419 (in Chinese with English abstract).

Wei H, Xu J H, Zhang G R, Cheng X H, Chu H X, Bian C J, Zhang Z Y. 2018. Hydrothermal metasomatism and gold mineralization of porphyritic granite in the Dongping deposit, North Hebei, China: Evidence from zircon dating[J]. Minerals, 8(9): 363.

Ye Tianzhu, Lü Zhicheng, Pang Zhenshan, Zhang Dehui, Wang Quanming, Liu Jiajun, Liu Shiyi, Cheng Zhizhong, Li Chaoling, Xiao Keyan, Zhen Shimin, Du Zezhong, Chen Zhengle. 2014. Theories and methods of prospecting prediction in prospecting areas (general)[M]. Beijing: Geological Publishing House (in Chinese).

Ye Tianzhu, Wei Changshan, Wang Yuwang, Zhu Xinyou, Pang Zhenshan, Yao Shuzhen, Qin Kezhang, Han Runsheng, Ye Huishou, Sun Jinggui, Cai Yuqi, Zhen Shimin, Xue Jianling. 2017. Theories and methods of prospecting prediction in prospecting areas (monographs)[M]. Beijing: Geological Publishing House (in Chinese).

Ye Tianzhu, Zhang Zhiyong, Xiao Qinghui, Pan Guitang, Feng Yanfang. 2010. Technical requirements for the study of metallogenic geological background[M]. Beijing: Geological Publishing House (in Chinese).

Yin Jianzhao, Zhai Yusheng. 1994. On the metallogenic series of gold deposits in Zhangjiakou–Xuanhua region, Hebei[J]. 14(4): 359–369(in Chinese with English abstract).

Zhen S M, Wang Q F, Wang D Z, Carranza E J M, Liu J J, Pang Z S, Cheng Z Z, Xue J L, Wang J, Zha Z J. 2020a. Genesis of the Zhangquanzhuang gold deposit in the northern margin of North China Craton: Constraints from deposit geology and ore isotope geochemistry[J]. Ore Geology Reviews, 122: 103511.

Zhen S M, Wang D Z, Yu X F, Wang Q F, Li Y S, Zha Z J, Wang J. 2020b. Trace elements and sulfur isotopes of sulfides in the Zhangquanzhuang gold deposit, Hebei Province, China: Implications for physicochemical conditions and mineral deposition mechanisms[J]. Minerals, 10−1089.

Zhen Shimin, Bai Haijun, Miao Jianpu, Jia Ruya, Yao Lei. 2020c. 1：50 000 Mineral Geological Map Database of the Chongli Map-sheet, Hebei Province, China[DB/OL]. Geoscientific Data & Discovery Publishing System. (2020-12-30). DOI: 10.35080/data.C.2020.P25.

Zheng Yadong, Song Guanxiang, Li Guanghui, Zhang Chen. 1990. Structural analysis of Dongping gold–bearing quarz vein system in Chongli County, Hebei Province[J]. Contributions to Geology and Mineral Resources Research, 5(2): 20−28 (in Chinese with English abstract).

Zuo Qunchao, Huang Xuzhao, Yang Donglai, Zhang Minghua, Feng Yanfang, Wu Xuan, Zhang Dequan, Yu Xuezheng, Chen Zhenghui, Li Jingchao. 2012. Data model of mineral resource potential evaluation: data item terms[M]. Beijing: Geological Publishing House (in Chinese).

Zuo Qunchao, Yang Donglai, Wang Xinqing. 2011. Data model of mineral resource potential evaluation[M]. Beijing: Geological Publishing House (in Chinese).