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吉林省石人镇幅 1∶50 000 矿产地质图数据库

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摘要：吉林省石人镇幅（K52E013003）1∶50 000 矿产地质图是依据《矿产地质调查技术要求（1∶50 000）》(DD2019-02)，在充分利用原 1∶50 000 区域地质调查工作成果资料的基础上，以成矿作用类型为主线、以成矿要素为对象、以预研究为基础、以矿产地质专项填图为核心，采用室内与室外填编图相结合的方法完成的。该工作积极探索创新了矿产地质专项填图成果表达方式，基本查明石人镇幅地层层序并详细划分了沉积岩、侵入岩和变质岩的建造类型，在建造构造图的基础上添加地理信息及矿产信息编制矿产地质图，突出成矿信息的表达。在矿产综合检查、成矿规律总结的基础上，初步圈定金找矿靶区 6 处，预测资源量 65.09 t，为今后找矿突破提供了基础地质依据及找矿方向。本数据库包含 1 张 MapGIS 矢量矿产地质图，以及 7 个样品的全岩地球化学分析数据，20 个样品的主量、微量和稀土元素的岩石地球化学分析数据和 16 个样品的锆石 U–Pb 同位素测年数据，13 条金及多金属矿产地信息，矿床成因类型分别为石英脉型和蚀变岩型，累计查明资源储量矿石量 1098.41 ×10^4 t，金的金属量 49 989 kg，矿床平均品位 4.55 g/t，数据容量约 80.70 MB。该数据库充分反映了 1∶50 000 矿产地质专项填图成果，为今后找矿提供了基础地质依据及找矿方向。

关键词：石人镇幅；专项填图；建造；成矿信息；矿产地；矿产地质图；矿产调查工程；吉林省

数据服务系统网址：http://dcc.cgs.gov.cn

1 引言

吉林省石人镇幅（K52E013003）调查区大地构造位置位于柴达木—华北板块（Ⅰ级构造单元）的华北陆块区（Ⅱ级构造单元），新元古代—早三叠世陆表海盆地（Ⅲ级构造单元）的两道江—松江河陆表海沉积盆地（Ⅳ级构造单元）(图 1)[❶]。

调查区位于营口—长白（次级隆起）Pb–Zn–Fe–Au–Ag–U–B–菱镁矿–滑石成矿带(Ⅲ–56–②) 中的南岔—荒沟山 Au–Ag–Fe–Cu–Pb–Zn–S 找矿远景区（Ⅴ34）内。成矿带

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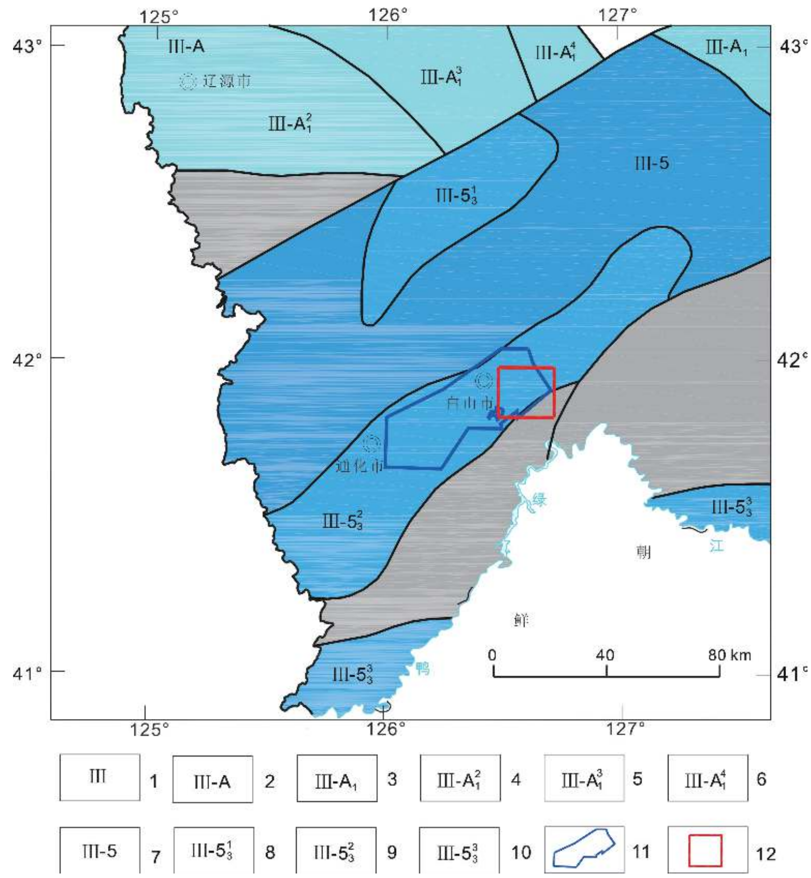

图 1　调查区大地构造位置图

1—柴达木—华北板块；2—华北陆块北部陆缘造山带；3—哈兰达岭—英额岭新元古代—古生代叠覆造山亚带；4—石嘴子—山秀岭晚古生代弧盆系；5—下二台—江域残留早古生代增生楔；6—西保安—青龙村新元古代残留构造岩片；7—华北陆块；8—样子哨—两江口陆表海沉积盆地；9—两道江—松江河陆表海沉积盆地；10—集安—长白陆表海沉积盆地；11—吉林省白山市板石沟地区铁及金矿整装勘查区范围；12—石人镇幅工作范围

沿天桥岭、石青沟、小石人和大镜沟一线展布，出露有老秃顶子岩体和草山岩体，呈北东向条带状展布，矿产以金和铁为主❷。

成矿带内金矿成矿条件优越，不同地质单元接触带往往是成矿的有利部位（图 2），如古元古界老岭群珍珠门组白云质大理岩与大栗子组千枚岩、片岩的接触界面，其两侧形成多个中小型金及多金属矿床，包括南岔破碎带蚀变岩型金矿（关键，2001）、大横路沉积变质–岩浆热液改造型钴铜矿（郭文秀等，2002）、荒沟山中低温热液型金矿（李洪文，2009）、荒沟山沉积改造型铅锌矿（冯守忠等，2005）、双顶岭中低温热液型金矿（刘勇等，2018）、大栗子热水喷流沉积型铁及多金属矿（尹悦，2019）及老岭化学沉积型铁矿。调查区所在整装勘查区内已发现的金英金矿是颇具规模和研究价值的大型金矿，成因类型为远成低温热液型金矿（陈煜嵩，2019），累计查明资源储量矿石量 1 098.41×10^4 t，金的金属量 49 989 kg，矿床平均品位 4.55 g/t❸。区域矿产特征如表 1 所示。

吉林省石人镇幅图幅区于 1989—1993 年完成 1：50 000 区域地质调查❹，确定了区内老岭群变质作用类型和期次，厘定了区内花岗岩形成于印支期，归并了地质单元和地层序列，划分了构造单元，并明确了各单元的具体边界和主要地层分布界线，建立了调查区的区域构造格架；于 1990 年完成 1：50 000 水系沉积物测量❺，较系统地分析出 13 种化学元素在横路岭—荒沟山“S”型断裂构造及韧性剪切带中的分布特征，为本次

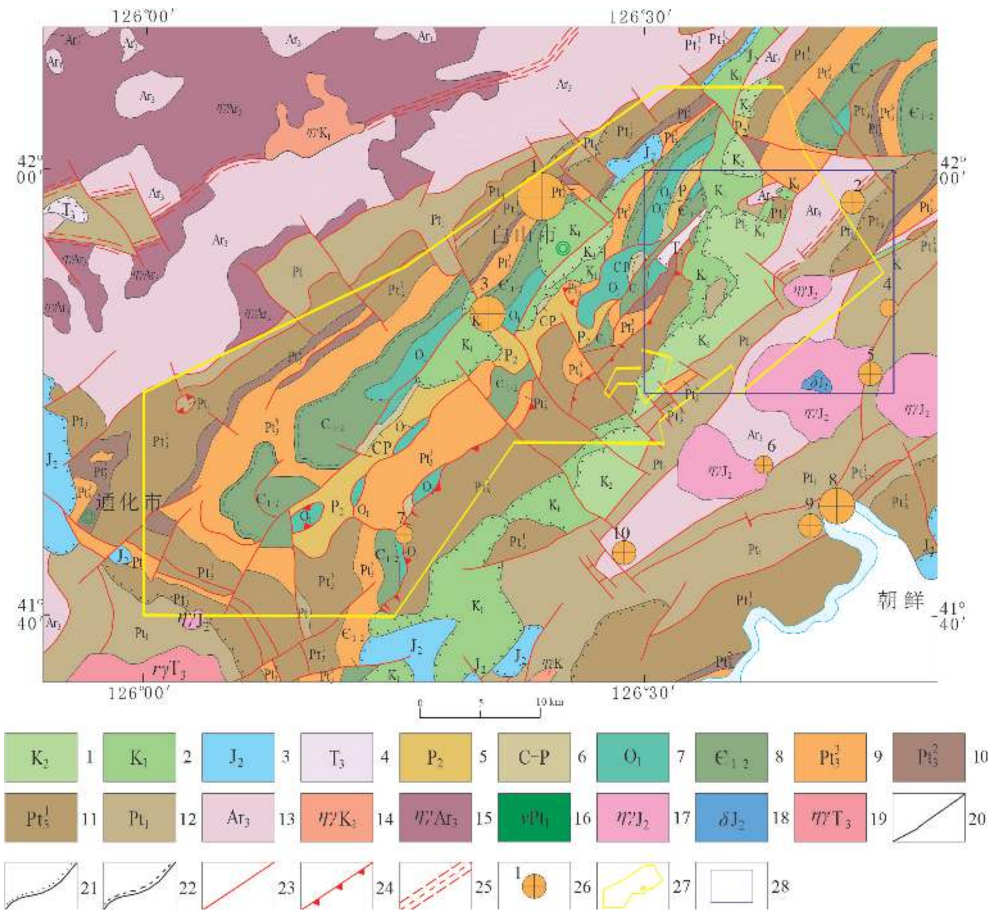

图 2　吉林省白山市板石沟地区铁及金矿整装勘查区区域地质简图

1—白垩系上统；2—白垩系下统；3—侏罗系中统；4—三叠系上统；5—二叠系中统；6—石炭二叠系；7—奥陶系下统；8—寒武系下统—上统；9—震旦系；10—南华系；11—青白口系；12—古元古代；13—新太古代变质表壳岩；14—早白垩世二长花岗岩；15—新太古代二长花岗岩；16—古元古代辉长岩；17—中侏罗世二长花岗岩；18—中侏罗世闪长岩；19—晚二叠世二长花岗岩；20—地质界线；21—角度不整合界线；22—平行不整合界线；23—断层界线；24—逆冲推覆构造；25—韧性剪切带；26—金矿；27—吉林省白山市板石沟地区铁及金矿整装勘查区范围；28—石人镇幅工作范围

矿产调查工作的开展提供了靶区；于 1989 年完成 1∶50 000 航空磁法测量[6]，基本查明了调查区的基本构造轮廓和格架。以上前人工作对本次开展吉林省石人镇幅 1∶50 000 矿产地质图的编制提供了基础数据和资料。

吉林省石人镇幅 1∶50 000 矿产地质图是自然资源部勘查技术指导中心于 2017 年从全国 78 个同类子项目中遴选的 7 个试点图幅之一，通过 1∶50 000 专项矿产地质填图，积极探索创新矿产地质专项填图成果表达方式，在建造构造图的基础上添加地理信息及矿产信息编制矿产地质图，以求对矿产地质调查项目的实施起到规范和指导作用，推动矿产地质调查取得新突破[7]。吉林省石人镇幅 1∶50 000 矿产地质图数据库（王海建等，2020）的元数据简表如表 2 所示。

2　数据采集和处理方法

2.1　数据基础

吉林省石人镇幅 1∶50 000 矿产地质图数据库的建设是按照《矿产地质调查技术要

表 1　吉林省白山市板石沟地区整装勘查区区域金矿床基本特征表

编号	名称	矿种	规模	成因类型	成矿时代	查明资源储量
1	板庙子金矿	金	大型	远成中低温热液型	中生代	金49.99 t
2	天桥金矿	金	小型	中低温热液型	中生代	金1.56 t
3	狼洞沟金银矿	金, 共生银	中型	矽卡岩型	中生代	银206 t、金5.75 t
4	前八里沟金矿	金	小型	中低温热液型	中生代	金0.10 t
5	八里沟金矿	金	小型	中低温热液型	中生代	金0.15 t
6	大松树金矿点	金	矿点	中低温热液型	中生代	
7	二道沟金矿点	金	矿点	远成中低温热液型	中生代	
8	荒沟山金矿	金	中型	中低温热液型	中生代	金9.32 t
9	错草沟金矿	金, 伴生银	小型	中低温热液型	中生代	金0.61 t、银2 t
10	双顶沟岭金矿	金	小型	中低温热液型	古元古代—太古宙	金2.58 t

表 2　数据库（集）元数据简表

条目	描述
数据库（集）名称	吉林省石人镇幅1∶50 000矿产地质图数据库
数据库（集）作者	沉积岩类：王海建，吉林省第四地质调查所 变质岩类：车海龙，吉林省第四地质调查所 岩浆岩类：吴玉诗，吉林省第四地质调查所
数据时间范围	2016.05—2017.03
地理区域	位于吉林省东南部，白山市板石沟地区铁及金矿整装勘查区东部，面积384 km^2 地理坐标：E 126°30′00″ ~ 126°45′00″；N 41°50′00″ ~ 42°00′00″
数据格式	*.jpg，*.wt，*.wl，*.wp
数据量	80.70 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“整装勘查区找矿预测与技术应用示范（121201004000150017）”子项目“吉林省白山市板石沟地区铁及金矿整装勘查区矿产调查与找矿预测（编号：121201004000150017-28）”
语种	中文
数据库（集）组成	吉林省石人镇幅1∶50 000矿产地质图数据库包括1∶50 000地质图库和整饰。地质图库分为地理和地质图层。地理图层包括地名、道路、水系；地质图层包括沉积岩建造、变质岩建造、侵入岩建造、脉岩、构造、地质界线、产状、矿床（点）、蚀变、岩性花纹、各类代号、典型矿床平面图、典型矿床剖面图、图切地质剖面图、矿产图例、矿产地名录、矿化蚀变图例、成矿区带位置图。整饰部分包括接图表、中国地质调查局局徽、图名、比例尺、坐标参数、责任签等

求（1∶50 000）》（DD2019−02）、《数字地质图空间数据库》（DD2006−06）要求，以“成矿地质体、成矿构造和成矿结构面、成矿作用特征标志”的三位一体找矿预测理论与方法（叶天竺等，2015）的理论指导调查区找矿预测工作，以吉林省石人镇幅1∶50 000 区域地质调查原始资料[4]（包括实际材料图、剖面图、路线地质调查记录本等）为基础，充分结合本次石人镇幅 1∶50 000 矿产地质专项填图新成果，采用室内与室外填编图相结合的方法完成。地理底图采用国家测绘地理信息局 2016 年绘制 1∶50 000 地形图。应用已有的技术标准、数字填图系统（DGSS）（李超岭等，2002；左群超等，2018）和 MapGIS 6.7 等计算机软件进行数据处理。

2.2 数据处理过程

2.2.1 数据准备

将收集到的 1：50 000 石人镇幅区域地质调查成果、矿产地和矿化点资料，结合 1：50 000 专项填图实测资料进行数字化处理，形成 MapGIS 点（.wt）、线（.wl）、面（.wp）文件。根据石人镇幅图幅范围生成 1：50 000 标准图框，投影类型为“高斯–克吕格（横切椭圆柱等角）投影”，椭球参数为“2000 国家大地坐标（CGCS2 000）”。

2.2.2 编制建造–构造草图

以石人镇幅 1：50 000 区域地质调查成果资料为基础，以 1：25 000 地形图为底图，参照野外路线和实测地质剖面等实际材料，确定填图基本单元，并将野外记录的岩性建造以点或线花纹的形式表达在实际材料图上，编制建造–构造草图。

2.2.2.1 建造

按照《地质图用色标准及用色原则（1：50 000）》（DZ/T 0179−1997）的用色标准，使用不同颜色的面图元表达建造的时代，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“组号+序号”表达，如钓鱼台组第一个建造代号表示为 Qbd^{a}。

2.2.2.2 脉岩

按照统一的用色标准，使用面图元的颜色表达岩性，代号用岩性符号表示，如花岗细晶岩代号表示为 $\lambda\pi$。

2.2.2.3 构造

（1）断裂构造

按照统一的用色标准使用红色统一表示，使用不同的线型表达断裂构造的性质。

（2）褶皱构造

按照褶皱构造的核部轨迹划尖角线，断线表示向斜构造，实线表示背斜构造。

2.2.2.4 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。

2.2.2.5 岩石化学样品采样点

使用“标准子图号+样品编号”表达采样点位置，并建立数据库。

2.2.2.6 地球化学样品采样点

使用“标准子图号+样品编号”表达采样点位置，并建立数据库。

2.2.2.7 稳定同位素样品采样点

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

根据已有资料的综合分析整理和预研究，结合整装勘查区内主攻矿床类型，划分重点工作区和一般工作区，选择石青沟—老岭村一带和大南岔—天桥金矿一带 2 个重点工作区，剩余图幅面积为一般工作区。数字填图掌机中以 1：25 000 实际材料图为底图，在数字填图系统中标绘出地质点、地质界线及路线等点、线信息，观察并录入各点的点性、岩性、产状、矿化蚀变等信息，初步建立数字填图原始（PRB）数据库。

地质点（P）：分为控制点、界线点和构造观测点。在数字填图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。

点间路线（R）：在系统中填写的属性包括路线号、地质点号、方位角、本站距离、累计距离、填图单元和岩石名称。其中，方位角、本站距离、累计距离为系统自动计算。对沿途所见的地质产状和采集的标本信息，随时在系统中定位录入相关信息，填写属性数据。

地质界线（B）：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、倾向及倾角。

2.2.4　室内数据整理

2.2.4.1　野外数据入库

将野外采集的地质点（P）、点间路线（R）、地质界线（B）数据资料导入数字填图电脑系统中，并根据相应规范进行数据整理。

（1）地质点（P）入库过程：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，岩石名称与对话框中地质描述保持一致（包括颜色、结构、构造等），如有薄片鉴定成果则在批注信息内进行描述，并按照实际情况综合定名后填写。

（2）点间路线（R）入库过程：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）”工作流程进行。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）入库过程：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、线性及线宽等参数。补充地质界线描述信息，用“界线左侧为 xxx，界线右侧为 xxx”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 2 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、照片入库过程：补充产状、采样等相应属性描述信息。产状编号在换地质点后重新从 1、2、3 等开始编号，照片按照入库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。

（5）室内化学分析数据入库过程：收到化学分析报告后，按照样品编号在样品管理数据库测试成果一栏选中“岩矿成分分析成果”功能，分别设置岩矿成分、成分含量单位后填写成分含量。

2.2.4.2　地质连图

将以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、岩性建造花纹、反映各类建造的构造形态进行修正，对新绘制的地质单元界线进行勾连。

2.2.5　图件编制

2.2.5.1　编制主图

在地层层序划分的基础上进行岩石组合划分并勾连出岩石组合界线，充填颜色及花纹，形成建造–构造图。在建造–构造图的基础上添加地理信息及矿产信息，形成矿产地质图。

2.2.5.2　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、侵入岩建造柱状图和变质岩建造柱状图。

2.2.5.3　典型矿床

在收集以往资料成果的基础上，充分借鉴本次典型矿床野外实地调查与综合研究的成果，编制典型矿床相关图件，包括金英金矿（典型矿床）地质简图及36线勘探线剖面图，为本区的找矿预测工作提供参考。

2.2.5.4　图切剖面

图幅区内建造和构造的总体走向为北东向和北西向，为了能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1条南东向和1条北北东向的图切剖面，北北东向图切剖面贯穿图幅内新太古代英云闪长岩、奥长花岗岩，中生代侏罗纪花岗岩，南东向图切剖面贯穿图幅内古元古代老岭群变质岩和新元古代青白口系碎屑岩、震旦系碳酸盐岩，古生代寒武系、奥陶系、石炭系、二叠系碳酸盐岩，中生代白垩系碳酸盐岩。表达方式主要使用了“标准剖面线型+标准代号”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。

2.2.5.5　矿产地名录

对图幅区内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和总结，编制形成矿产地名录。

2.2.5.6　所处成矿区带位置图

该图用于展示石人镇幅的区域大地构造位置及其区域地质背景。在收集吉林省1：50 000区域成矿规律图的基础上，根据图幅区位置确立的区域轮廓范围进行适当裁剪，保留Ⅰ～Ⅴ成矿区带和主要的地名和矿床，然后进行缩放，形成石人镇幅所属成矿区带位置图。

区域轮廓范围必须满足以下4个条件：（1）以工作图幅为中心位置；（2）能包括石人镇幅预测矿产的完整区域成矿带范围；（3）能包括预测矿产区域所属成矿带的相关区域构造带完整范围；（4）能包括预测矿产相关的成矿地质体控（成）岩构造带相对完整范围。

2.2.5.7　其他整饰部分

对脉岩、构造、矿化蚀变等内容进行梳理，编制各种图例。

经过上述各步工作，完成吉林省石人镇幅1：50 000矿产地质图（图3）的编制。

3　数据样本描述

3.1　数据的命名方式

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、第四系、构造、地质界线、产状、矿产地、矿化蚀变、各类代号等。

角图内容包括接图表、柱状图、图例、图切剖面、典型矿床成矿要素图、典型矿床实测剖面图、矿产地名录、所属成矿区带位置图、责任签等。

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。

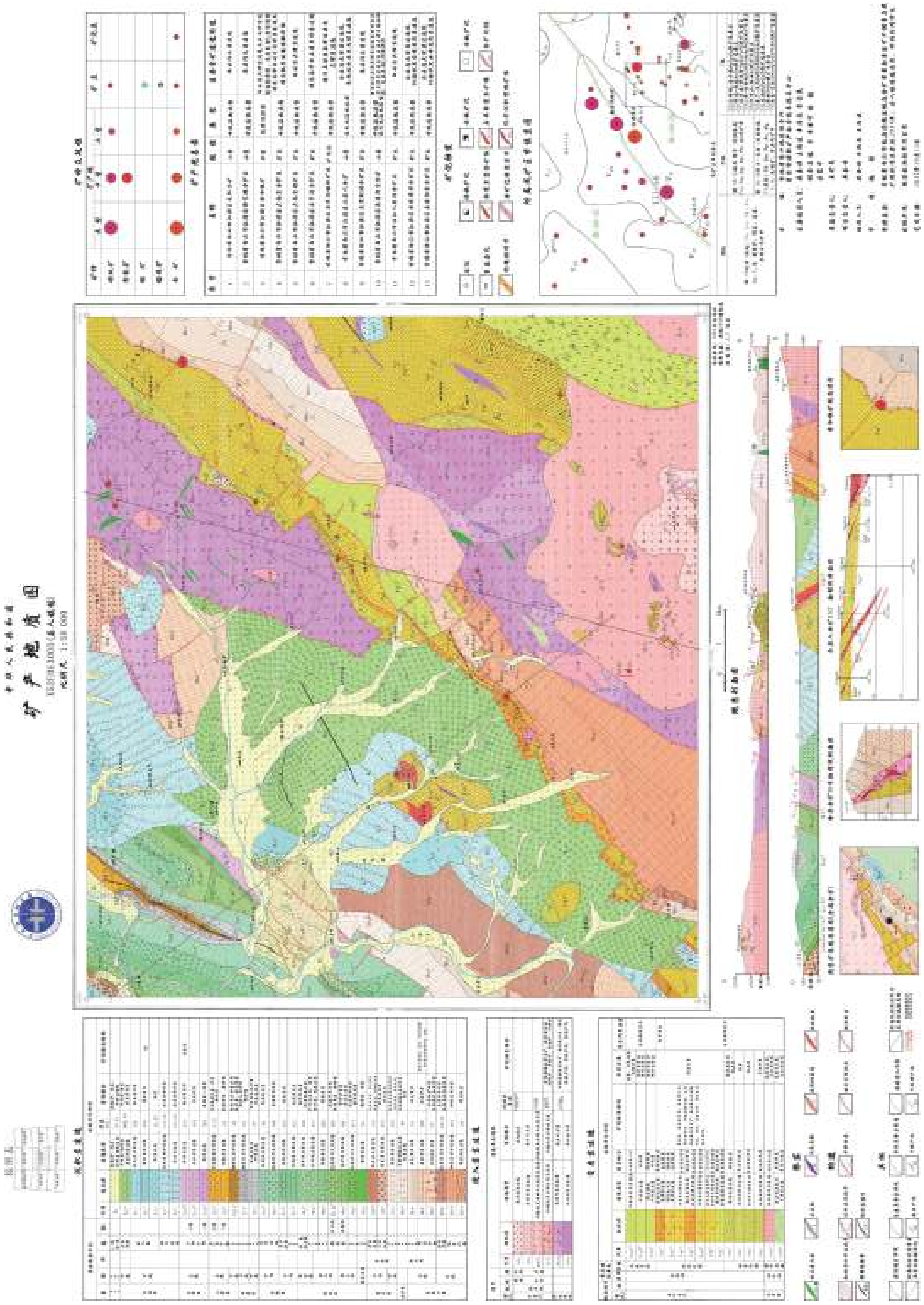

图3 吉林省石人镇幅1：50 000矿产地质图示意图

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、第四系等。

3.4 数据属性

吉林省石人镇幅（K52E013003）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 矿产地质调查专项地质填图数据库建库要求分 4 大岩类（沉积岩、火山岩、侵入岩、变质岩）、断裂构造、产状、矿产地等分别建立数据库属性。

沉积岩建造数据属性主要有：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。

侵入岩建造数据属性主要有：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。

变质岩建造数据属性主要有：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。

断裂构造数据属性主要有：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。

产状数据属性有：产状类型、倾向、倾角。

矿产地数据属性主要有：矿产地编号、矿产地名称、矿产地类别、交通位置、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。

4 数据质量控制和评估

填图精度按照《矿产地质调查技术要求（1∶50 000）》（DD 2019−02）采用填、编结合的方法，对成矿有利的重点调查区及新发现的矿化线索以实测为主，以地质剖面、主干路线、专项点以及找矿路线等方法和手段开展面上填图工作。对于经检查后有进一步工作价值的矿化线索，采用加密路线进行重点检查，以详细控制矿化地质体的地表分布范围为目的，为槽探工程揭露提供依据。一般工作区根据《石人镇幅、苇沙河幅、花山幅、临江幅 1∶50 000 区域地质调查报告》原始资料为主，辅以少量野外地质路线进行调查。

数据质量方面，填图路线自检率、互检率达 100%，项目组抽检率 30%，严格实行子项目承担单位、子项目组、班组的三级质量检查验收制度，符合地质调查项目质量管理要求。地质空间数据库建设工程中，严格遵循中国地质调查局地质调查技术标准《数字地质图空间数据库》（DD2006−06）相关要求执行，主要质量监控措施包括：（1）过程监控：每做完一步，建库人员均进行 100% 自检、项目组 100% 互检，主要检查接边属性和拓扑关系是否正确，数据入库后检查图幅显示是否完整，按图例、图层检查属性及面元颜色是否正确等；（2）属性数据检查：检查图层名称的标准化程度、图层属性表是否齐全、记录是否完整、属性代码是否正确、数据项内容和图元与属性的对应性

等，在建库过程中经过多层次、多环节的质量检查与监督，确保数据库中数据准确无误；（3）图面质量检查：对 MapGIS 输出的全要素彩色喷墨地质图内、图外整饰部分的注记、子图等规范性，地质图颜色、压盖关系处理以及角图绘制合理性等问题，聘请地质专家进行了 5 次图面检查工作。

项目实施单位中国地质调查局发展研究中心对项目实施全过程实行全面监控。2016 年 11 月 26 日—27 日中国地质调查局发展研究中心与吉林省国土资源厅组织专家在白山市采用室内、野外相结合的方式对项目组 2016 年度野外工作进行了验收，野外验收综合评分 90 分，为优秀级。

5 数据价值

吉林省石人镇幅（K52E013003）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。该矿产地质图在深入研究本图幅区内沉积序列的岩石组成和结构构造的基础上，结合本次 1：50 000 矿产地质专项填图成果，按照《矿产地质调查技术要求（1：50 000）》（DD 2019−02），以建造为划分原则，通过建造—构造与矿产成因相关性的综合分析与研究，凸显矿产特色、阐明成矿要素、指明找矿方向，促进区域矿产地质调查取得新突破。

5.1 沉积岩建造

本次共划分沉积岩建造 35 个（表 3）。将青白口系达台山组划分为 2 个建造，马达岭组、钓鱼台组、桥头组各划分 1 个建造，钓鱼台组石英砂岩建造为金、铁矿的赋矿地质体，发育有远成低温热液型金英金矿及化学沉积型老岭铁矿，金矿体赋存于该套建造与珍珠门组白云质大理岩建造接触部位的不整合界面内，化学沉积型老岭铁（赤铁矿）矿赋存于该套建造的底砾岩内；震旦系万隆组、八道江组、青沟子组各划分 1 个建造；寒武系水洞组、昌平组、馒头组东热段和河口段、张夏组、崮山组、炒米店子组各划分 1 个建造，水洞组的粉砂岩建造为区域上石膏矿赋矿建造；奥陶系冶里组、亮甲山组各划分 1 个建造，马家沟组划分 2 个建造；石炭系本溪组、太原组、山西组各划分 1 个建造；二叠系石河子组划分 2 个建造；三叠系小河口组划分 2 个建造；白垩系林子头组划分 2 个建造，石人组划分 3 个建造，小南沟组划分 1 个建造，石人组的炭质页岩建造含煤；第四系全新统划分 1 个建造。

5.2 侵入岩建造

共划分侵入岩建造 6 个（表 4）。分别为新太古代奥长花岗岩建造、英云闪长岩建造；中侏罗世似斑状黑云母花岗岩建造、似斑状黑云母二长花岗岩建造、花岗闪长岩建造；晚侏罗世花岗斑岩建造。

5.3 变质岩建造

共划分变质岩建造 16 个（表 5）。分别将太古宙鞍山群杨家店组划分为 2 个建造，古元古代老岭群林家沟组划分为 4 个建造、珍珠门组划分为 7 个建造、大栗子组划分为 3 个建造，珍珠门组二段、三段建造为金矿成矿地质体。

5.4 典型矿床“三位一体”特征

整装勘查区以金矿为主攻矿种，本图幅参考整装勘查区浑江市幅内的金英金矿做为远成低温热液型金矿的典型矿床进行综合分析及研究。

表 3　沉积岩建造特征一览表

年代地层单位		岩石地层单位			建造单元特征			
系	统	群	组	段	代号	建造类型	厚度/m	岩性组合
第四系	全新统		Ⅰ级阶地		Q_4^a	松散砂、砾石、河卵石堆积建造	5~10	松散砂、砾石、河卵石堆积
白垩系	中统		小南沟组		K_2x^a	中砾岩—粗砾岩夹巨砾岩建造	969.88	中砾岩—粗砾岩夹巨砾岩
	上统		石人组		K_1s^c	凝灰质砂岩建造	826	凝灰质砂岩
					K_1s^b	炭质页岩建造	930	炭质页岩
					K_1s^a	砾岩建造	32.10	砾岩
			林子头组		K_1l^b	凝灰质粉砂岩建造	131.36	凝灰质粉砂岩
					K_1l^a	凝灰岩建造	121.32	凝灰质粉砂岩
三叠系	上统		小河口组	二段	T_3xh^{2b}	粉砂岩建造	319	粉砂岩夹煤
					T_3xh^{2a}	长石砂岩建造	481	长石砂岩
				一段	T_3xh^{1a}	砾岩建造	764	巨砾岩—砾岩
二叠系	中统		石盒子组	二段	P_2s^{2a}	含砾粗粒砂岩建造	4.61	含砾粗粒砂岩、砂岩及粉砂岩
				一段	P_2s^{1a}	细粒砂岩建造	31	细粒砂岩、粉砂岩
石炭系	上统		山西组		$C_2P_1s^a$	粗粒长石砂岩建造	45	粗粒长石砂岩夹煤、粉砂岩、杂色页岩
			太原组		C_2t^a	粗粒长石砂岩建造	84	粗粒长石砂岩、粉砂岩
	下统		本溪组		C_2b^a	含云母长石砂岩建造	70	含云母长石砂岩、砂岩夹煤层
奥陶系	中统		马家沟组		O_2m^b	角砾状灰岩建造	49	角砾状灰岩
					O_2m^a	亮晶砂屑灰岩建造	586	亮晶砂屑灰岩
	下统		亮甲山组		O_2l^a	豹皮灰岩建造	527	豹皮灰岩
			冶里组		O_2y^a	含泥质灰岩建造	527	含泥质灰岩

续表 3

年代地层单位		岩石地层单位			建造单元特征			
系	统	群	组	段	代号	建造类型	厚度/m	岩性组合
寒武系	芙蓉统		炒米店子组		$Є_3c^a$	条带状灰岩建造	446	条带状灰岩、纹层泥晶灰岩
			崮山组		$Є_3g^a$	竹叶状灰岩建造	317	竹叶状灰岩、页岩、粉砂岩、泥晶灰岩
	第三统							
			张夏组		$Є_3z^a$	鲕状灰岩建造	353	鲕状灰岩
			馒头组	河口段	$Є_{1\text{-}2}m^{ha}$	亮晶砂屑灰岩建造	346	亮晶砂屑灰岩、砾屑灰岩、粉砂岩
	第二统			东热段	$Є_{1\text{-}2}m^{da}$	粉砂质页岩建造	66	粉砂质页岩、白云质灰岩
			昌平组		$Є_1c^a$	亮晶砂屑灰岩建造	211	亮晶砂屑灰岩、条带状灰岩
			水洞组		$Є_1s^a$	粉砂岩建造	55	粉砂岩、砂岩
震旦系	中统	浑江群	青沟子组		Z_2qg^a	白云质灰岩建造	110	白云质灰岩、黑色页岩、泥晶灰岩、角砾状灰岩
			八道江组		Z_2b^a	叠层石灰岩建造	371	叠层石灰岩、碎屑灰岩
	下统		万隆组		Z_2w^a	纹层灰岩建造	355	纹层灰岩夹薄层粉砂岩、钙质页岩、藻屑灰岩
青白口系		细河群	桥头组		Qbq^a	含铁锈斑点石英砂岩建造	40	含铁锈斑点石英砂岩、页岩
			南芬组		Qbn^a	杂色页岩建造	54	杂色页岩
			钓鱼台组		Qbd^b	石英砂岩建造	250	石英砂岩
					Qbd^a	含赤铁矿砾岩	35	含赤铁矿砾岩、含赤铁矿石英砂岩
			马达岭组		Qbm^a	长石石英砂岩建造	64.33	长石石英砂岩、含砾长石石英砂岩
			达台山组		$Qbdt^b$	细粒石英砂岩建造	491	细粒石英砂岩
					$Qbdt^a$	炭质板岩建造	36	炭质板岩

表 4　侵入岩建造特征一览表

时代				建造单元特征			
代	纪	世	期	代号	建造类型	岩性特征	同位素年龄/Ma
中生代	侏罗纪	晚侏罗世	早期	$\gamma\pi J_3$	花岗斑岩建造	花岗斑岩	152.87±1.85，全岩K–Ar
		中侏罗世	早期	$\gamma\delta J_2$	花岗闪长岩建造	花岗闪长岩	
				$\eta\gamma\beta J_2$	似斑状黑云母二长花岗岩建造	似斑状黑云母二长花岗岩	176±7，锆石U–Pb
				$\gamma\beta J_2$	似斑状黑云母花岗岩建造	似斑状黑云母花岗岩	178±8，锆石U–Pb
新太古代				$\gamma\delta o$Ar	英云闪长岩建造	英云闪长岩	2 570，Rb–Sr等时线
				γoAr	奥长花岗岩建造	奥长花岗岩	

表 5　变质岩建造特征一览表

时代		岩石地层单位		建造单元特征		
代	纪	岩群	岩组	代号	建造类型	岩性特征
古元古代		老岭群	大栗子组	Pt_1dl^{2b}	二云石英片岩建造	二云石英片岩
				Pt_1dl^{2a}	千枚岩建造	千枚岩
				Pt_1dl^{1a}	绢云绿泥千枚岩建造	绢云绿泥千枚岩
			珍珠门组	Pt_1z^{3c}	角砾状白云质大理岩建造	角砾状白云质大理岩
				Pt_1z^{3b}	硅化白云质大理岩建造	硅化白云质大理岩
				Pt_1z^{3a}	白云质大理岩建造	白云质大理岩
				Pt_1z^{2c}	炭质条带状白云质大理岩建造	炭质条带状白云质大理岩
				Pt_1z^{2b}	白云质大理岩建造	白云质大理岩
				Pt_1z^{2a}	透闪石硅质条带状白云质大理岩建造	透闪石条带状白云质大理岩
				Pt_1z^{1a}	炭质条带状白云质大理岩建造	炭质条带状白云质大理岩
			林家沟组	Pt_1l^d	炭质板岩建造	炭质板岩
				Pt_1l^c	黑云变粒岩建造	黑云变粒岩
				Pt_1l^b	白云质大理岩建造	白云质大理岩
				Pt_1l^a	长石石英岩建造	长石石英岩
太古宙		鞍山群	杨家店组	$Ar\gamma y^b$	斜长角闪岩建造	斜长角闪岩
				$Ar\gamma y^a$	黑云斜长角闪片麻岩建造	黑云斜长角闪片麻岩

5.4.1　成矿地质体

金英金矿的成矿地质体[7]为：（1）古元古界珍珠门组角砾状白云质大理岩建造及新元古界钓鱼台组底部含赤铁矿石英砂岩建造，用于提供成矿物质，是成矿物质成分的汇聚源，与矿体在时间、空间和物质成分等方面有成因联系；（2）燕山中晚期中基性岩浆岩建造为金矿的形成提供物源或热源。

5.4.2　成矿构造和成矿结构面

（1）成矿构造

成矿构造包括：珍珠门组角砾状白云质大理岩建造与钓鱼台组含赤铁矿石英砂岩建造之间角度不整合构造；叠加在角度不整合接触界面上的北东向断裂构造（F_{100}）；发

育在角砾状白云质建造与含赤铁矿石英砂岩建造内的北东向断裂（F_{102}），及与北西向断裂交汇部位。

（2）成矿结构面

物理化学界面为氧化–还原转换界面；构造界面以北东向张性断裂结构面（F_{100}）为主，为温度–压力骤降界面，构造活动形成降温减压；岩性及地质体界面为古元古界珍珠门组角砾状白云质大理岩建造与新元古界钓鱼台组底部含赤铁矿石英砂岩建造之间角度不整合界面。

5.4.3　成矿作用特征

金英金矿成矿作用特征突出表现为岩性、构造、地质体界面，或与物理化学界面的叠加界面对成矿最有利。成矿物质在温度变换、压力变换、酸碱度变换、氧化还原条件变换的界面附近聚集和沉淀。构造界面、岩性、地质体界面和物理化学界面相互叠加，形成叠加成矿结构界面，是金英金矿形成的重要条件。

6　结论

（1）通过 1∶50 000 矿产地质专项填图，基本查明石人镇幅（K52E013003）地层层序并详细划分了沉积岩、侵入岩和变质岩的建造类型，在建造–构造图的基础上添加地理信息及矿产信息编制形成矿产地质图，突出了成矿信息的表达。

（2）遵循勘查区“三位一体”找矿理论表达了矿床的成矿条件、找矿标志，确定了图幅内主要含矿建造，并建立了区域典型矿床金英金矿的三位一体成矿模型。通过矿产综合检查及成矿规律研究工作，初步圈定 6 处金找矿靶区，累计预测资源量 65.09 t，其中，板庙子式远成低温热液型金找矿靶区 2 处，预测资源量 15.20 t；中低温热液型（石英脉型）金找矿靶区 4 处，预测资源量 49.89 t。以上成果的取得，为今后找矿突破提供了基础地质依据及找矿方向。

（3）石人镇幅（K52E013003）1∶50 000 矿产地质图是中国地质调查局新一轮地质矿产调查的示范图幅，积极探索了创新矿产地质专项填图成果表达方式。形成的石人镇幅矿产地质图对专项矿产地质调查起到示范作用。

致谢：吉林省石人镇幅 1∶50 000 矿产地质图数据库是一项集体成果，野外一线地质工作人员付出了辛勤的努力。在矿产地质图数据库的建立过程中，得到多位地质矿产专家的辛勤指导，在此对各位专家和野外项目组所有成员表示最诚挚的感谢。

注释：

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Database of 1∶50 000 Mineral Geological Map of the Shiren Town Map-sheet, Jilin Province

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Abstract: The 1∶50 000 mineral geological map of the Shiren Town map-sheet (K52E013003) in Jilin Province was prepared by adopting indoor and field mapping (compilation) according to the *Technical Requirement of* 1∶50 000 *Solid Mineral Geological Survey* (DD 2019-02), during which the results of previous 1∶50 000 regional geological surveys were fully utilized. With mineralization types as the main line, this project focused on mineral and geology-specific mapping based on a preliminary study and mainly researched metallogenic factors. Meanwhile, the presentation of geology-specific mapping results was actively explored and innovated, the stratigraphic sequences of the Shiren Town map-sheet were basically ascertained, and the sedimentary rock suites, intrusion suites, and metamorphic rock suites were determined in detail. The map was completed by adding geographic data and mineral resource information to the suite-tectonic map, highlighting the expression of metallogenic information. The database of the map (also referred to as the Database) contains a mineral geological vector map in MapGIS format, whole-rock petrogeochemical data of seven samples, petrogeochemical data of major, trace, and rare earth elements of 20 samples, and zircon U–Pb isotopic dating data of 16 samples. Besides, it includes the data of 13 gold and polymetallic deposits, whose genetic types are quartz vein and alteration types. The total amount of resource reserves is 1 098.41 $\times 10^4$ t, and that of gold is 49 989 kg, with the average Au grade of 4.55 g/t. With a data size of about 80.70 MB, the database fully reflects the results of 1∶50 000 mineral and geology-specific mapping, thus providing basic geological bases and prospecting direction for future strategic actions on prospecting breakthroughs.

Key words: Shiren Town map-sheet; specific mapping; suite; metallogenic information; deposit; mineral geological map; mineral survey engineering; Jilin Province

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

1 Introduction

The survey site of the Shiren Town map-sheet (K52E013003) in Jilin Province is located in the North China Craton (a second-order tectonic unit) of Qaidam−North China Plate (a first-order tectonic unit) and in the Liangdaojiang−Songjiang epicontinental sedimentary basin (a fourth-order tectonic unit) of Neoproterozoic-Early Triassic epicontinental basin (a third-order tectonic unit) (Fig. 1)[1].

The survey site lies in the Nancha−Huanggoushan Au-Ag-Fe-Cu-Pb-Zn-S prospecting

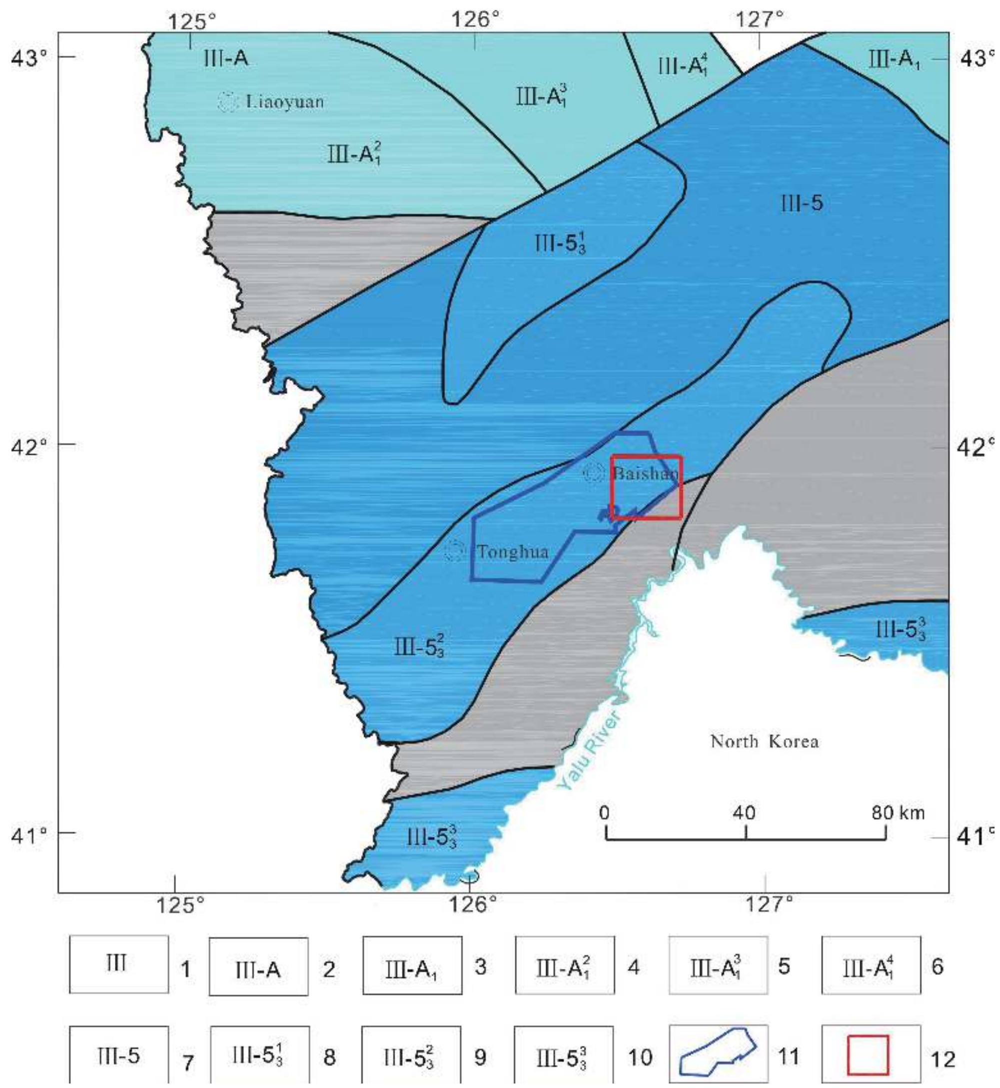

Fig. 1 Geotectonic location map of the survey area

1—Qaidam−North China Plate; 2—Epicontinental orogenic belt of North China Craton; 3—Neoproterozoic−Paleozoic superimposition orogenic sub-belt in Harlanda Ridge−Ying'e Ridge area; 4—Late Paleozoic arc-basin system in Shizuizi−Shanxiu Ridge; 5—Residual early Paleozoic accretionary wedge in Xia'ertai−Jiangyu area; 6—Neoproterozoic residual lithotectonic slices in Xibaoan−Qinglongchun area; 7—North China Craton; 8—Epicontinental sedimentary basin in Yangzishao−Liangjiangkou area; 9—Epicontinental sedimentary basin in Liangdaojiang−Songjianghe area; 10—Epicontinental sedimentary basin in Ji'an−Changbai area; 11—Integrated exploration area of iron and gold deposits in Banshigou area, Baishan City, Jilin Province; 12— Survey area of the Shiren Town map-sheet area (V34) of Yingkou−Changbai (secondary uplift) Pb-Zn-Au-Ag-U-B-magnesite-talc metallogenic belt (III-56-②). The metallogenic belt in the map-sheet is distributed in a banded form along Tianqiaoling, Shiqianggou, Xiaoshiren, and Dajinggou areas in NE trending, with the outcrops including Laotudingzi and Caoshan rock masses. Meanwhile, the minerals in these areas are mainly comprised of gold and iron[2].

The metallogenic belt enjoys superior metallogenic conditions of gold deposits. The contact zones between different geological units tend to serve as favorable metallogenic parts (Fig. 2), such as the contact interface between the dolomitic marble of the Zhenzhumen Formation and the phyllites and schists of Dalizi Formation in the Paleoproterozoic Laoling Group. Multiple medium-small gold and polymetallic deposits have formed on both sides of the contact surface, including the alteration-type gold deposit in Nancha fractured zone (Guan J, 2001), Dahenglu cobalt-copper deposit of sedimentary metamorphism–magmatic-

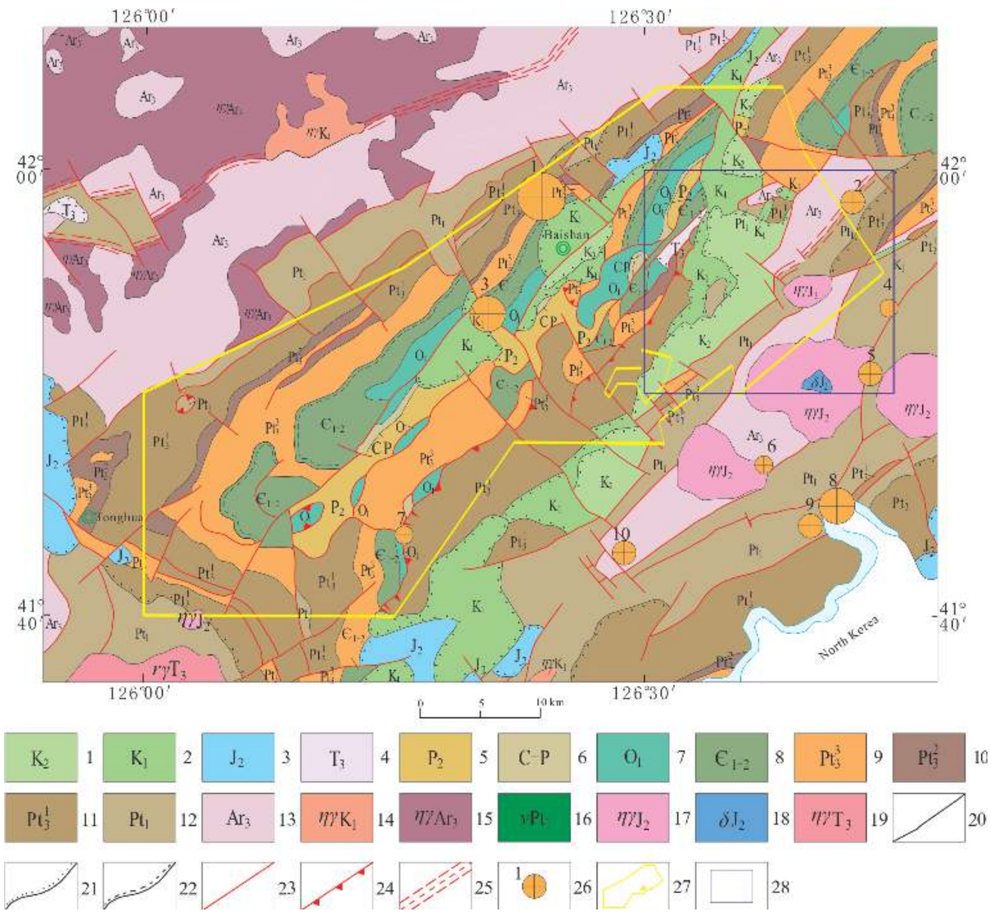

Fig. 2 Regional geological map of integrated exploration area of iron and gold deposits in Banshigou, Baishan City, Jilin Province

1—Upper Cretaceous; 2—Lower Cretaceous; 3—Middle Jurassic; 4—Upper Triassic; 5—Middle Permian; 6—Permo-Carboniferous; 7—Lower Ordovician; 8—Lower−Upper Cambrian; 9—Sinian; 10—Nanhuanian; 11—Qingbaikouan System; 12—Palaeoproterozoic; 13—Neoarchean metamorphic supracrustal rocks; 14—Early Cretaceous monzogranite; 15—Neoarchean monzonitic granite; 16—Paleoproterozoic gabbro; 17—Middle Jurassic monzonitic granite; 18—Middle Jurassic diorite; 19—Late Permian monzonitic granite; 20—Geological boundary; 21—Angle unconformity boundary; 22—Parallel unconformity boundary; 23—Fault boundary; 24—Thrust nappe structure; 25—Ductile shear zone; 26—Gold deposit; 27—Integrated exploration area of iron and gold deposits in Banshigou, Baishan City, Jilin Province; 28—Survey scope of the Shiren Town map-sheet hydrothermal transformation origin (Guo WX et al., 2002), Huanggoushan meso-epithermal gold deposit (Li HW, 2009), Huanggoushan lead-zinc deposit of sedimentation-transformation type (Feng SZ et al., 2005), Shuangdingling meso-epithermal gold deposit (Liu Y et al., 2018), Dalizi SEDEX iron and polymetallic deposit (Yin Y, 2019), and Laoling chemical sedimentary iron deposit. The Jinying gold deposit discovered in the integrated exploration area where the survey site belongs to is a large telethermal gold deposit, deserving research (Chen YS, 2019). It boasts an accumulative identified resource reserves of 1 098.41×10^4 t, 49 989 kg of gold and an average grade of 4.55 g/t[❸]. The characteristics of regional mineral resources are shown in Table 1.

Previous surveys conducted in the Shiren Town map-sheet area, Jilin Province are as follows. From 1989 to 1993, 1：50 000 regional geological surveys were conducted in the map-sheet[❹], during which the following achievements were obtained: ①The types and stages of the metamorphism in Laoling Group in the map-sheet were identified. ②The granites in the area were determined to have formed in Indo-Chinese epoch. ③Relevant geological units and stratigraphic sequences were combined. ④Tectonic units were classified and the specific boundaries of each unit and main stratigraphic boundaries were identified, and in this way, the regional tectonic framework of the survey site was established. In 1990, a 1：50 000 stream

Table 1 Basic characteristics of regional gold deposits in the integrated exploration area of Banshigou, Baishan City, Jilin Province

No.	Deposit name	Mineral type	Scale	Genetic type of deposit	Metallogenetic epoch	Identified resources reserve
1	Banmiaozi gold deposit	Au	large	telethermal low-to-moderate temperature hydrothermal deposit	Mesozoic	Au 49.99 t
2	Tianqiao gold deposit	Au	small	low-to-moderate temperature hydrothermal deposit	Mesozoic	Au 1.56 t
3	Langdonggou goldargentid deposit	Au, Ag	medium	skarn-type deposit	Mesozoic	Ag 206 t, Au 5.75 t
4	Qianbaligou gold deposit	Au	small	low-to-moderate temperature hydrothermal deposit	Mesozoic	Au 0.10 t
5	Baligou gold deposit	Au	small	low-to-moderate temperature hydrothermal deposit	Mesozoic	Au 0.15 t
6	Dasongshu gold occurrence	Au	ore occurrence	low-to-moderate temperature hydrothermal deposit	Mesozoic	
7	Erligou gold occurrence	Au	ore occurrence	telethermal low-to-moderate temperature hydrothermal deposit	Mesozoic	
8	Huanggoushan gold deposit	Au	medium	low-to-moderate temperature hydrothermal deposit	Mesozoic	Au 9.32 t
9	Cuocaogou gold deposit	Au, associated Ag	small	low-to-moderate temperature hydrothermal deposit	Mesozoic	Au 0.61 t, Ag 2 t
10	Shuangdinggouling gold deposit	Au	small	low-to-moderate temperature hydrothermal deposit	Archean–Paleo proterozoic	Au 2.58 t

sediment survey was completed[5], during which the distribution characteristics of 13 chemical elements in S-shaped fault structure and ductile shear zone in Hengluling–Huanggoushan area were systematically analyzed, providing target areas for the mineral resource survey of this project. In 1989, a 1∶50 000 aeromagnetic survey was performed[6], ascertaining the basic structural outline and framework of the survey site. All these surveys provide basic data for the preparation of 1∶50 000 mineral geological map of Shiren Town map-sheet in Jilin Province.

The 1∶50 000 mineral geological map of the Shiren Town map-sheet, Jilin Province is one of the seven pilot map-sheets selected from 78 similar subprojects across China by the Exploration Technical Guidance Center of the Ministry of Natural Resources of the People's Republic of China in 2017. The expression of mineral and geology-specific mapping results was actively explored and innovated through the 1∶50 000 mineral and geology-specific mapping. In detail, the mineral geological map was prepared by adding geographic information and mineral resource information to suite-tectonic maps, in an effort to standardize and provide guidance for the implementation of mineral and geological survey projects and to help make new breakthroughs in mineral and geological surveys[7]. The brief metadata table of the Database (Wang HJ et al., 2020) is shown in Table 2.

2 Methods for Data Acquisition and Processing

2.1 Data Basis

The Database was completed following the "trinity" prospecting prediction theory and method that integrate metallogenic geological bodies, metallogenic structures, metallogenic structural planes, and metallogenic characteristics and indications (Ye TZ et al., 2015) according to the *Technical Requirement of* 1∶50 000 *Solid Mineral Geological Survey* (DD 2019-02) and the *Standard on Spatial Databases for Digital Geologic maps* (DD 2006-06). To this end, new results of 1∶50 000 mineral and geology-specific mapping of the Shiren Town map-sheet were fully combined with the draft data acquired from previous 1∶50 000 regional geological surveys of the map-sheet (including draft data maps, sections, and records of geological survey routes) and the indoor mapping (compilation) was combined with field mapping (compilation). The geographic base map was 1∶50 000 topographic map plotted by the National Bureau of Surveying, Mapping and Geoinformation of China in 2016, and the data were processed by applying existing technical standards and computer software such as the digital mapping system (DGSS) (Li CL et al., 2002; Zuo QC et al., 2018) and MapGIS 6.7.

2.2 Data Processing

2.2.1 Data Preparation

Data digitization was conducted for the 1∶50 000 regional geological survey results collected and the data on the ore deposits and mineralized points in the Shiren Town map-sheet based on the measured data obtained during 1∶50 000 specific mapping. As a result, the files of geological points (.wt), lines (.wl) and polygons (.wp) were generated. Meanwhile, the 1∶50 000-scale standard map frame was created according to the range of Shiren Town map-

Table 2 Metadata Table of Database (Dataset)

Item	Description
Database (dataset) name	Database of 1∶50 000 Mineral Geological Map of the Shiren Town Map-sheet, Jilin Province
Database (dataset) authors	Sedimentary rocks: Wang Haijian, The Fourth Geological Survey of Jilin Province Metamorphic rocks: Che Hailong, The Fourth Geological Survey of Jilin Province Igneous rocks: Wu Yushi, The Fourth Geological Survey of Jilin Province
Data acquisition time	From May 2016 to March 2017
Geographical area	Located in the eastern part of the integrated exploration area of iron and gold deposit in Banshigou, Baishan City, Southeastern Jilin Province, covering an area of 384 km^2; Coordinates: 126°30′00″−126°45′00″E; 41°50′00″−42°00′00″N
Data formats	*.jpg, *.wt, *.wl, *.wp
Data size	80.70 MB
Data service system URL	http://dcc.cgs.gov.cn
Fund project	The project titled *Mineral Resources Survey and Prospecting Predication of Integrated Exploration Area of Iron and Gold Deposits in Banshigou Area, Baishan City, Jilin Province* (No.: 121201004000 150017-28), which is a subject of the geological survey project titled *Prospecting Predication of Integrated Exploration Areas and Technical Application Demonstration* (No.: 121201004000150017) initiated by the China Geological Survey
Language	Chinese
Database (dataset) composition	The Database consists of a library of 1∶50 000 mineral geological maps and map decorations. The map library includes geographic and geological map layers. The former include geographic name, roads and water system, while the latter include sedimentary rock suites, metamorphic rock suites, intrusive rock suites, vein rocks, structures, geological boundaries, attitude, deposits (mineralized points), alteration, lithologic patterns, various codes, plans and sections of typical deposits, geological cross-sections, mineral legends, mineral deposit list, mineralized alteration legends, and maps of metallogenic area and belt locations. The map decorations contain index maps, logo of the China Geological Survey, map title, scale, coordinate parameters, and signatures

sheet, with Gauss–Kruger (transverse elliptic cylinder equiangular) projection and the ellipsoid parameter of National Geodetic Coordinate System 2000 (CGCS2000).

2.2.2 Preparation of Suite-Tectonic Draft Maps

Basic mapping units were determined from the base map (1∶25 000 topographic map) by referring to the surveyed data in the 1∶50 000 regional geological survey results of the map-sheet such as field routes and geological sections. Then the suite-tectonic draft map was prepared by presenting the lithologic formations recorded during field survey in the forms of points or lines on the draft data map.

2.2.2.1 Suites

The eras of suites were presented with graphic primitives in different colors according to the *Standard and Principle of Coloring in Geologic Map* (DZ/T 0179-1997). The suites were presented with suite patterns and rock associations were expressed with corresponding patterns. Meanwhile, a suite code was expressed using formation code + a serial number. For instance, the code of the first suite of the Diaoyutai Formation was Qbd^{a}.

2.2.2.2 Veins

The lithology of veins was presented with colors of graphic primitives according to a uniform color standard. Meanwhile, the code of a dike was expressed with a lithology code. For example, the code of aplite was $\lambda\pi$.

2.2.2.3 Structures

(1) Faults

Faults were expressed uniformly in red, and their properties were expressed with different line types.

(2) Folds

Folds were expressed with sharp angle-shaped lines painted according to the trajectory of their cores, with dotted lines indicating syncline structures and solid lines indicating anticline structures.

2.2.2.4 Geological sections

For a geological section, the location was presented with “standard section line types + section code” , an actual control point with the geological point and its number, and the lithology of each stratum with proper patterns. Meanwhile, the attitude elements were presented on geological sections.

2.2.2.5 Sampling points of petrochemical samples

The sampling location of a petrochemical sample was presented with “standard sub-map no. + sample no.”, and a sample database was created.

2.2.2.6 Sampling points of geochemical samples

The sampling location of a geochemical sample was presented with “standard sub-map no. + sample no.”, and a sample database was created.

2.2.2.7 Sampling points of stable isotopic samples

The sampling location of a stable isotopic sample was presented with “standard sub-map no. and sample no.”, and a sample database was created.

2.2.3 Specific Geological Field Mapping

The survey site was divided into key survey sites and minor survey sites based on comprehensive analysis and collation of existing data as well as main target deposit types in the integrated exploration area. The former included Shiqinggou−Laolingcun area and Danancha−Tianqiao gold deposit area, and the latter referred to remaining map-sheet area. The points and lines such as geological points, boundary points, geological boundaries, and survey routes were labeled and marked in the digital mapping system, with 1：25 000 draft data maps in palm-sized personal digital assistants (PDAs) for digital mapping serving as base maps. Meanwhile, the information such as the features, lithology, attitude, and mineralized alteration of each point were observed and input. In this way, the original digital mapping (PRB) database was preliminarily created.

Geological points (P): including control points, boundary points, and structural observation points. Simple attributes of geologic points were filled in the digital mapping system, including such as geologic point no., point features, micro-landform, outcrops, weathering degree, location description, mapping unit, and contact relationships. Meanwhile, the coordinates were automatically read from the system.

Geological routes between points (R): the attributes that were filled in the digital mapping system included route no., geological point no., azimuthal angle, the distance of current workstation, cumulative distance, mapping unit, and rock names. Among them, the azimuthal angle, the distance of current workstation, and the accumulative distance were automatically calculated by the system. For the geological attitude and collected specimen along the route, they were positioned and relevant information was input and their attribute data were filled in the system at any time.

Geological boundaries (B): the attributes that were filled in the digital mapping system included route no., geological point no., boundary code, route code, boundary type, mapping units on the left and right sides, contact relationship, strike, dip and dip angle.

2.2.4 Indoor Data Sorting

2.2.4.1 Inputting Field Data to Database

The data of geological points (P), routes (R) and boundaries (B) collected in the field were imported into the digital mapping system and were sorted out according to applicable specifications.

(1) Inputting process of geological points (P). Fill in the information such as the route no., weathering degree, and contact relationship completely filled according to actual conditions. Fill the mapping units with the codes of corresponding mapping units and make the rock names consistent with those input into the dialogue box of geological description (including color, tectonics, and structure). Describe thin section identification results (if any) in labels and fill in them after naming them comprehensively according to actual conditions.

(2) Inputting process of routes between points (R). Input geological routes indoor following the order of "smoothing curve → modifying line parameters (line type: 1; color: 1; line width: 0) → calculating routes between points → (make statistics of workload)" . Supplement and improve the databases of route attributes and re-calculate the orientations and distance of the routes before describing the geological conditions of the routes.

(3) Inputting process of geological boundaries (B). Make the geological boundaries aesthetically pleasing by cutting or extending lines on visual software according to contact relationships. Select the parameters such as color, line type, and line width in a uniform way. Supplement the description of geological boundaries. Express the lithology of both sides of a boundary with consistent terminology such as "the left side consists of xxx and the right side consists of xxx". By default, the lithology of the left side is observed earlier than that of the right side. Additionally, describe the contact relationship between the lithology of two sides and its evidence.

(4) Inputting process of attitude, sampling, and photos along geological routes. Supplement descriptive information on the attributes such as attitude and sampling. Number the attitudes of a new geological point from “1” again. As for a photo, describe its contents and the geological phenomena it reflects in a detailed way after importing the photo.

(5) Inputting process of indoor chemical analysis data. After receiving chemical analysis reports, select the function of "Rock and mineral composition analysis results" in the list of test results of the sample management database according to the sample no. and set the rock and mineral components and their content units. Then fill in the composition content.

2.2.4.2 Geological Connecting

Two types of draft data maps were merged. One type mainly consists of field PRB data, while other type was regional geological survey maps that were collated during the preparation of the suite-tectonic draft maps. Then corrections were performed for boundaries between stratigraphic units, suite patterns, and tectonic morphology reflecting various suites, and the boundaries of newly formed geological units were connected.

2.2.5 Map Preparation

2.2.5.1 Preparation of Master Map

Based on the stratigraphic sequences divided, rock associations were divided after their boundaries were delineated and their colors and patterns were filled. In this way, the suite-tectonic map was formed. Then the mineral geological map took shape by adding geographic and mineral resource information to the suite-tectonic map.

2.2.5.2 Histograms of Suites

The characteristics of the suites in the lithostratigraphic units on the master map were expressed in detail. Specifically, the histograms of sedimentary rock suites, volcanic rock suites, intrusive rock suites, and metamorphic rock suites were prepared based on the comprehensive analysis and study of various suites and structures within the map-sheet and their relationship with mineralization.

2.2.5.3 Typical Deposits

Related maps of typical deposits were compiled by collecting previous data and outcomes and fully referring to the field survey results and comprehensive research of typical deposits in this project. These maps included the geological sketch of the Jinying gold deposit (a typical deposit) and the exploration line section of line No. 36, aiming to provide references for the prospecting prediction in the map-sheet.

2.2.5.4 Cross-sections

The suites and structures within the map-sheet are in NE and NW trending in general. To effectively reflect the overall characteristics of these suites and structures and their relationship with mineralization, one SE-trending and one NNE-trending cross-sections were arranged. The NNE-trending one ran through the Neoarchean tonalite and trondhjemite and Jurassic granite of the Mesozoic within the map-sheet, while the SE-trending one ran through the Paleoproterozoic metamorphic rocks in Laoling Group, Qingbaikouan clastic rocks and Sinian carbonate rocks of the Neoproterozoic, the Cambrian, Ordovician, Carboniferous and Permian carbonate rocks of the Paleozoic, and Cretaceous carbonate rocks of the Mesozoic. The cross-sections were presented as follows: their positions were expressed with standard line type and section code, the actual control points with geological points and their nos., and the lithology of each stratum with proper patterns. Meanwhile, the attitude elements were expressed on cross-sections.

2.2.5.5 List of Mineral Deposits

The list of mineral deposits within the map-sheet was established by analyzing and summarizing the mineral deposits from the aspects of name, scale, type, and main ore-bearing suites.

2.2.5.6 Map of Metallogenic Zone/Belt Locations

The map of metallogenic zone/belt locations is used to reflect the regional geotectonic position and regional geological setting of the Shiren Town map-sheet. It was prepared as follows: clipping the collected 1∶50 000 regional metallogenic regularity map of Jilin Province properly according to the regional outline range of the sheet area to reserve metallogenic belts I–V and main place names and deposits; scaling the map slipped.

The regional outline range must be determined in accordance with the following four criteria: (1) the Shiren Town map-sheet serving as the center; (2) including the complete regional metallogenic belt of predicated mineral resources in the Shiren Town map-sheet; (3) including the complete range of the regional tectonic belts that are related to the metallogenic belt covering the predicated mineral resource area; (4) including the relatively complete range of control (diagenetic) rock tectonic zones of the metallogenic geologic blocks that are related to predicated mineral resources.

2.2.5.7 Other Decorations

The contents such as veins, structures and mineralized alteration were collated and corresponding legends were prepared.

Through above-mentioned steps, the 1∶50 000 mineral geological map (Fig. 3) of the Shiren Town map-sheet in Jilin Province was completed.

3 Description of Data Samples

3.1 Naming Method of Data

Geological polygons (. wp), geological lines (. wl) and geological points (. wt).

3.2 Contents in Map Layers

The master map consists of sedimentary rock suites, volcanic rock suites, intrusive rock suites, metamorphic rock suites, Quaternary, structures, geological boundaries, attitude, mineral deposits, mineralized alteration and various codes.

The corner maps include index map, histograms, legends, cross-sections, metallogenic factor maps of typical deposits, surveyed sections of typical deposits, list of mineral deposits, maps of metallogenic belt location and signatures.

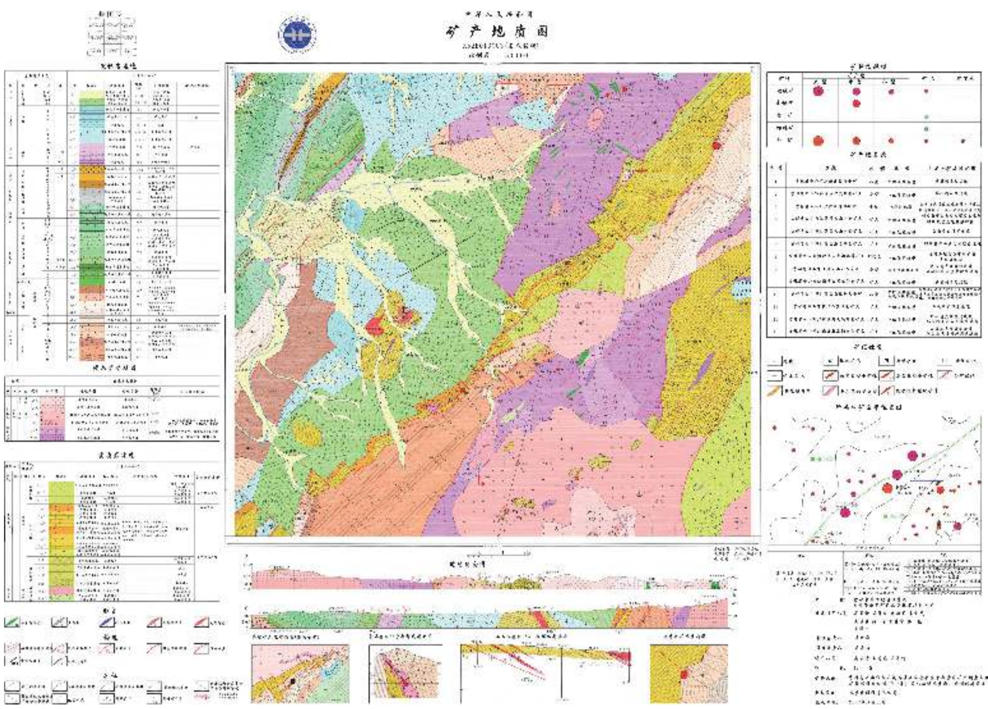

Fig. 3　Schematic diagram of 1：50 000 mineral geological map of the Shiren Town map-sheet, Jilin Province

3.3　Data Types

Name of geological entity types: points, lines, and polygons.

Points: symbols and marks of various geologic blocks, geologic patterns, mineral deposits, and mineralized alteration.

Lines: fault structures, geological boundaries, lithofacies boundary, etc.

Polygons: sedimentary rocks, volcanic rocks, metamorphic rocks, intrusions, the Quaternary, etc.

3.4　Data Attributes

The Database includes the data of geological entity elements, geographical elements and geologic map decorations. The attributes of geographical elements follow the attribute structures used by the National Bureau of Surveying, Mapping and Geoinformation of China to collect data. In terms of the geologic entity elements, database attributes were individually established for four major types of rocks (sedimentary rocks, volcanic rocks, intrusions, and metamorphic rocks), fault structures, attitude, and mineral deposits according to the requirements for establishing a special geologic map database of 1：50 000 mineral and geological surveys. Various data attributes are described as follows.

Main data attributes of a sedimentary rock suite: chronostratigraphic unit; lithostratigraphic unit; the name, code, thickness, and ore-bearing features of the suite; lithological associations; stratigraphic age; rock texture; rock structure; sedimentary structures; rock colors; sedimentation type; sedimentary facies type, and synsedimentary structures.

Main data attributes of an intrusive rock suite: the name, code, and ore-bearing features of the suite; lithological associations; rock texture; rock structure; intrusion stage; attitude of rock masses; plane morphology; section morphology; tectonic characteristics of pluton emplacement; contact zone features; genetic type, and isotopic age.

Main data attributes of a metamorphic rock suite: chronostratigraphic unit; lithostratigraphic unit; the name, code, thickness, and ore-bearing features of the suite; lithological associations; stratigraphic age; rock texture; rock structure; protolith suite; metamorphic facies, and metamorphism type.

Main data attributes of a fault structure: the name, type, extension, depth, width, and strike of the fault; the dip, dip angle, and morphology of fault surface; fault throw; lithotectonic features; motion mode; active stage, and mechanical properties.

Data attributes of occurrence: occurrence type, dip, and dip angle.

Main data attributes of a mineral deposit: no., name, category, traffic location, geographic longitude, geographic latitude, mineral types, genetic type, scale, paragenetic (associated) minerals, and identified reserves.

4 Data Quality Control and Assessment

The Database was established by employing the method of geological mapping and map compilation, with the precision consistent with the *Technical Requirement of* 1 ∶ 50 000 *Solid Mineral Geological Survey* (DD 2019-02). The key survey sites favorable for mineralization and newly discovered mineralization clues were mapped mainly based on field surveys, focusing geological sections, major routes, special points, and prospecting routes. The mineralization clues deserving further survey according to checks were primarily inspected along denser routes, aiming to control the distribution range of mineralized geologic blocks on the ground surface in detail and to provide bases for trenching engineering. As for the minor survey sites, they were mapped primarily based on the original data in the 1 ∶ 50 000 *Regional Geological Survey Report of the Shiren Town, Weishahe, Huashan, and Linjiang Map-sheets* as well as the field survey of a small number of geological routes.

In terms of data quality, the self-check rate and mutual check rate of the survey routes of geological mapping routes were both 100%, and the rate of spot inspection conducted by the project team was 30%. Meanwhile, the three-level quality inspection and acceptance system consisting of the organization undertaking the establishment of the Database, project team, and shifts was strictly implemented, thus meeting the requirements of quality management for geological survey projects. The geological spatial database was established in strict accordance with the requirements of the *Standard on Spatial Databases for Digital Geologic maps* (DD 2006-06), a geological survey technical standard issued by the China Geological Survey, and the quality control measures mainly included: (1) Process monitoring. After each step, 100% self-check and 100% mutual check were conducted on edge match and topological relationship by database builders and the project team, respectively. After the data were input to database, checks were carried out on the completeness of map presentation and on attributes and graphic primitive colors according to legends and map layers. (2) Check on attribute data: checks were made on the standardization degree of layer names, the completeness of attribute data tables of map layers, completeness of records, the correctness of attribute codes, and the conformance of data items and primitives with attributes. Such multi-level and multi-link quality inspection and supervision ensured the accuracy of the data in the Database. (3) Check on map presentation: in terms of the presentation of the inkjet geologic map output from MapGIS that contain all feature classes, geological experts were retained to conduct checks five times on the normalization of map decorations such as labels and sub-maps inside and outside the map, the colors and overlapping relationship in the map, and the rationality of corner maps.

The Development and Research Center of China Geological Survey responsible for the establishment of the Database monitored the whole establishment process. During November 26–27, 2016, it, together with the Jilin Provincial Department of Land and Resources, organized experts to perform acceptance check on the field work in 2016 by indoor inspection combined with field inspection in Baishan City. As a result, the Database was scored 90 and rated excellent.

5 Date Value

The 1：50 000 mineral geological map of the Shiren Town map-sheet, Jilin Province (K52E013003) is a demonstration map-sheet of a new round of geological surveys initiated by the China Geological Survey. It was prepared in accordance with *Technical Requirement of* 1:50 000 *Solid Mineral Geological Survey* (DD 2019-02) based on an in-depth study on rock composition, texture, and structures of sedimentary sequences within the map-sheet and in combination with the 1：50 000 mineral and geology-specific mapping outcomes. It highlights mineral characteristics, clarifies metallogenic factors, and pointed out prospecting direction through suite classification as well as comprehensive analysis and research of the correlation of suites and structures with mineral genes. This will contribute to new breakthroughs in regional mineral and geological survey.

5.1 Sedimentary Rock Suites

Thirty-five sedimentary rock suites were determined (Table 3). The Qingbaikouanian Dataishan Formation was divided into two suites, and the Qingbaikouanian Madaling, Diaoyutai and Qiaotou suites were separately divided into one suite. The quartz sandstone suite of Diaoyutai Formation is an iron- and gold-bearing geologic block, with telethermal Jinying gold deposit and chemical sedimentary Laoling iron deposit having developed. The gold deposit occurs in the unconformity interface between the quartz sandstone suite of the Diaoyutai Formation and dolomitic marble suite of the Zhenzhumen Formation, while the chemical sedimentary Laoling iron (hematite) deposit developed in the basal conglomerate of the quartz sandstone suite of the Diaoyutai Formation. The Sinian Wanlong, Badaojiang, and Qinggouzi formations were each divided into one suite. The Cambrian strata including Shuidong Formation, Changping Formation, the Dongre and Hekou members of Mantou Formation, Zhangxia Formation, Gushan Formation, and Chaomidianzi Formation were separately divided into one suite. Among them, the siltstone suite of the Shuidong Formation is a regional gypsum-bearing suite. The Ordovician Yeli and Liangjiashan formations were

Table 3 List of characteristics of sedimentary rock suites

Chronological stratigraphic unit		Lithostratigraphic unit			Characteristics of suite units			
System	Series	Group	Formation	Member	Code	Type	Thickness/m	Lithological association
Quaternary	Holocene		First-order terrace		Q_4^{a}	loose sand, gravel and river pebbles accumulative suite	5–10	accumulation of loose sand, gravel and river pebbles
Cretaceous	Middle		Xiaonangou Formation		K_2x^{a}	suite of medium−coarse conglomerates interbedded with giant conglomerates	969.88	medium−coarse conglomerates interbedded with giant conglomerates
	Upper		Shiren Formation		K_1s^{c}	tuffaceous sandstone suite	826	tuffaceous sandstone
					K_1s^{b}	carbonaceous shale suite	930	carbonaceous shale
					K_1s^{a}	conglomerate suite	32.10	conglomerate
			Linzitou Formation		K_1l^{b}	tuffaceous siltstone suite	131.36	tuffaceous siltstone
					K_1l^{a}	tuff suite	121.32	tuffaceous siltstone
Triassic	Upper		Xiaohekou Formation	Member II	T_3xh^{2b}	siltstone suite	319	siltstone interbedded with coal
					T_3xh^{2a}	arkose suite	481	arkose
				Member I	T_3xh^{la}	conglomerate suite	764	giant conglomerate-conglomerate
Permian	Middle		Shihezi Formation	Member II	P_2s^{2a}	gravel-bearing coarse-grained sandstone suite	4.61	gravel-bearing coarse-grained sandstone, sandstone, and siltstone
				Member I	P_2s^{la}	fine-grained sandstone suite	31	fine-grained sandstone and siltstone
Carboniferous	Upper		Shanxi Formation		$C_2P_1s^{a}$	coarse-grained arkose suite	45	coarse-grained arkose interbedded with coal, siltstone, and variegated shale
			Taiyuan Formation		C_2t^{a}	coarse-grained arkose suite	84	coarse-grained arkose and siltstone
	Lower		Benxi Formation		C_2b^{a}	mica-bearing arkose suite	70	mica-bearing arkose and sandstone interbedded with coal
Ordovician	Middle		Majiagou Formation		O_2m^{b}	brecciaous limestone suite	49	brecciaous limestone
					O_2m^{a}	sparry calcarenite suite	586	sparry calcarenite
	Lower		Liangjiashan Formation		O_2l^{a}	leopard limestone suite	527	leopard limestone
			Yeli Formation		O_2y^{a}	argillaceous limestone suite	527	argillaceous limestone

Continued table 3

Chronological stratigraphic unit		Lithostratigraphic unit			Characteristics of suite units			
System	Series	Group	Formation	Member	Code	Type	Thickness/m	Lithological association
Cambrian	Furongian		Chaomidianzi Formation		Є$_{3}c^{a}$	banded limestone suite	446	banded limestone and lamellar micritic limestone
	Third		Gushan Formation		Є$_{3}g^{a}$	edgewise limestone suite	317	edgewise limestone, shale, siltstone, and micritic limestone
			Zhangxia Formation		Є$_{3}z^{a}$	oolitic limestone suite	353	oolitic limestone
	Second		Mantou Formation	Hekou Member	Є$_{1\text{-}2}m^{ha}$	sparry calcarenite suite	346	sparry calcarenite, calcarenite, and siltstone
				Dongre Member	Є$_{1\text{-}2}m^{da}$	silty shale suite	66	silty shale and dolomitic limestone
			Changping Formation		Є$_{1}c^{a}$	sparry calcarenite suite	211	sparry calcarenite and banded limestone
			Shuidong Formation		Є$_{1}s^{a}$	siltstone suite	55	siltstone and sandstone
Sinian	Middle	Hunjiang Group	Qinggouzi Formation		$Z_{2}qg^{a}$	dolomitic limestone suite	110	dolomitic limestone, black shale, micritic limestone, and brecciaous limestone
			Badaojiang Formation		$Z_{2}b^{a}$	stromatolite limestone suite	371	stromatolite limestone and calcarenite
	Lower		Wanlong Formation		$Z_{2}w^{a}$	lamellar limestone suite	355	lamellar limestone interbedded with -laminated siltstone, calcareous shale, and algal clast limestone
Qingbaikouan		Xihe Group	Qiaotou Formation		Qbq^{a}	rust spot-bearing quartz sandstone suite	40	rust spot-bearing quartz sandstone and shale
			Nanfen Formation		Qbn^{a}	variegated shale suite	54	variegated shale
			Diaoyutai Formation		Qbd^{b}	quartz sandstone suite	250	quartz sandstone
					Qbd^{a}	hematite-bearing conglomerate suite	35	hematite-bearing conglomerate hematite-bearing quartz sandstone
			Madaling Formation		Qbm^{a}	feldspathic quartz sandstone suite	64.33	feldspathic quartz sandstone gravel-bearing feldspathic quartz sandstone
			Dataishan Formation		Qbdt^{b}	fine-grained quartz sandstone suite	491	fine-grained quartz sandstone
					Qbdt^{a}	carbonaceous slate suite	36	carbonaceous slate

separately divided into one suite, and the Ordovician Majiagou Formation was divided into two suites. The Carboniferous Benxi, Taiyuan, and Shanxi formations were separately divided into one suite. The Permian Shihezi Formation was divided into two suites. The Triassic Xiaohekou Formation was divided into two suites. As for the Cretaceous strata, the Linzitou Formation was divided into two suites, the Shiren Formation was divided into three suites, and the Xiaonangou Formation was divided into one suite. Among them, the Carbonaceous shale suite of the Shiren Formation contains coal. Meanwhile, the Holocene (Quaternary) strata were divided into one suite.

5.2 Intrusive Rock Suites

Six intrusive rock suites were determined (Table 4), namely Neoarchean trondhjemite suite and tonalite suite; Middle Jurassic porphyritic biotite granite suite, porphyritic biotite monzogranite suite, and granodiorite suite, and Late Jurassic granite porphyry suite.

5.3 Metamorphic Rock Suites

16 metamorphic rock suites were determined (Table 5). In detail, the Yangjiadian Formation of Archean Anshan Group was divided into two suites, and the Linjiagou, Zhenzhumen, and Dalizi formations of the Palaeoproterozoic Laoling Group were divided into four, seven, and three suites, respectively. Among them, the suites of the second and third members of the Zhenzhumen Formation are metallogenic geologic blocks of gold.

5.4 "Trinity" Feature of Typical Deposits

Gold deposits were mainly researched in the integrated exploration area. The gold deposits in the Shiren Town map-sheet were comprehensively analyzed and researched by taking the Jinying gold deposit in Hunjiang City map-sheet of the integrated exploration area as a typical telethermal deposit.

5.4.1 Metallogenic Geologic Blocks

The metallogenic geologic blocks of the Jinying gold deposit[7] include: (1) The brecciaous dolomitic marble suite in the Paleoproterozoic Zhenzhumen Formation and the

Table 4 List of characteristics of intrusive rock suites

Age				Characteristics of suite units			
Era	Period	Epoch	Stage	Code	Type	Lithologic characteristic	Isotopic age/Ma
Mesozoic	Jurassic	Late Jurassic	Early	$\gamma\pi J_3$	granite porphyry suite	granite porphyry	152.87±1.85, whole-rock K–Ar age
		Middle Jurassic	Early	$\gamma\delta J_2$	granodiorite suite	granodiorite	
				$\eta\gamma\beta J_2$	porphyric biotite monzogranite suite	porphyric biotite monzogranite	176±7, zircon U–Pb age
				$\gamma\beta J_2$	porphyric biotite granite suite	porphyric biotite granite	178±8, zircon U–Pb age
Neoarchean				$\gamma\delta o Ar$	tonalite suite	tonalite	2 570, Rb–Sr isochron age
				$\gamma o Ar$	Trondhjemite granite suite	Trondhjemite	

Table 5 List of characteristics of metamorphic rock suites

Age		Lithostratigraphic unit		Characteristics of suite unit		
Era	Period	Group	Formation	Code	Type	Lithologic characteristic
Paleoproterozoic		Laoling Group	Dalizi Formation	Pt_1dl^{2b}	two-mica-quartz schist suite	two-mica-quartz schist
				Pt_1dl^{2a}	phyllite suite	phyllite
				Pt_1dl^{1a}	sericite-chlorite phyllite suite	sericite-chlorite phyllite
			Zhenzhumen Formation	Pt_1z^{3c}	brecciaous dolomitic marble suite	brecciaous dolomitic marble
				Pt_1z^{3b}	silicified dolomitic marble suite	silicified dolomitic marble
				Pt_1z^{3a}	dolomitic marble suite	dolomitic marble
				Pt_1z^{2c}	carbonaceous banded dolomitic marble suite	carbonaceous banded dolomitic marble
				Pt_1z^{2b}	dolomitic marble suite	dolomitic marble
				Pt_1z^{2a}	remolite-bearing siliceous banded dolomitic marble suite	remolite-bearing siliceous banded dolomitic marble
				Pt_1z^{1a}	carbonaceous banded dolomitic marble suite	carbonaceous banded dolomitic marble
			Linjiagou Formation	Pt_1l^{d}	carbonaceous slate suite	carbonaceous slate
				Pt_1l^{c}	biotite granulite suite	biotite granulite
				Pt_1l^{b}	dolomitic marble suite	dolomitic marble
				Pt_1l^{a}	arkose suite	arkose
Archean		Anshan Group	Yangjiadian Formation	Ary^{b}	amphibolite suite	amphibolite
				Ary^{a}	biotite-amphibolite gneiss suite	biotite-amphibolite gneiss

hematite-bearing quartz sandstone suite at the bottom of the Neoproterozoic Diaoyutai Formation. They serve as the metallogenic material sources and the sources where the metallogenic material constituents converge. There are genetic relations between these suites with the ore bodies in terms of time, space, and material constituents. (2) Middle–Late Yanshan middle-basic magmatic rock suite, serving as the material source or heat source for the formation of the gold deposit.

5.4.2 Metallogenic Structures and Metallogenic Structural Planes

(1) Metallogenic structures

The metallogenic structures include: (1) the angular unconformity between the brecciaous dolomitic marble suite of the Zhenzhumen Formation and the hematite-bearing quartz sandstone suite of the Diaoyutai Formation; (2) NE-trending fault (F_{100}) that is superimposed on the contact interface of angular unconformity; (3) NE-trending fault (F_{102}) that developed in brecciaous dolomitic suite and hematite-bearing quartz sandstone suite; (4) the part where F_{102}

intersects with the NW-trending fault.

(2) Metallogenic structural planes

The physical-chemical interfaces are oxidation-reduction conversion interfaces. The structural interfaces mainly include the structural plane of a NE-trending tensile fault (F_{100}), which is an interface subject to a sudden drop in temperature caused by tectonic activities. The lithologic and geologic block interface is the angular unconformity interface between the brecciaous dolomitic marble suite of the Paleoproterozoic Zhenzhumen Formation and the hematite-bearing quartz sandstone suite at the bottom of the Neoproterozoic Diaoyutai Formation.

5.4.3 Characteristics of Mineralization

The striking metallogenic characteristic of the Jinying gold deposit is that the interfaces forming from overlapping of lithologic interfaces, structural interfaces, geologic block interfaces, or physical-chemical interfaces are the most favorable for mineralization. Metallogenic materials have converged and precipitated near the interfaces subject to changes in temperature, pressure, pH, and redox conditions. Superimposed metallogenic structure interfaces forming from overlapping of various interfaces serve as an important metallogenic condition of the Jinying gold deposit.

6 Conclusions

(1) Based on the 1：50 000 mineral and geology-specific mapping of Shiren Town map-sheet (K52E013003), Jilin Province, the stratigraphic sequences of the map-sheet were basically ascertained and sedimentary rock suites, intrusion suites and metamorphic rock suites were classified in detail. Then the 1：50 000 mineral geological map was prepared by adding geographic data and mineral resource information to the suite-tectonic map, highlighting the expression of metallogenic information.

(2) The metallogenic conditions prospecting theory, the main ore-bearing suites within the map-sheet were determined, and the "trinity" metallogenic model of the Jinying gold deposit (a typical regional deposit) was established. Through the comprehensive inspection of mineral resources and the study of metallogenic regularities, six prospecting targets were preliminarily delineated, and the cumulative predicted resources was 65.09 t. Among them, two Banmiaozi-type telethermal low-temperature hydrothermal gold prospecting targets were delineated with predicted resources of 15.20 t, and four low-to-moderate temperature hydrothermal (quartz vein-type) gold prospecting targets were also delineated with predicted resources of 49.89 t. All these results could provide basic geological basis and prospecting direction for future breakthroughs in prospecting.

(3) The 1：50 000 mineral geological map of the Shiren Town map-sheet (K52E013003) is a demonstration map-sheet of a new round of geological surveys initiated by the China Geological Survey. It was prepared based on active exploration and innovation of special geologic mapping results, setting an example for special mineral geological survey.

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Shiren Town, Jilin Province is a collective achievement, for which the frontline geological engineers have made great efforts. Meanwhile, multiple experts in geology and mineral resources provided diligent guidance during the establishment of the database. The authors hereby extend sincere gratitude to the experts and all frontline project members.

Notes:

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