

南蒙古及邻区地质矿产简图及地形地貌特点

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Explanatory Notes for the Simplified Geology and Mineral Resource Map and Typical Geographical and Topographic Features of Southern Mongolian and Its Neighboring Areas

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南蒙古及邻区地处华北板块与西伯利亚板块之间的中亚-蒙古巨型造山带内, 属准噶尔-南蒙古-大兴安岭造山系中东部, 主要由一系列向南凸的弧形构造-岩浆岩带所构成。这一地区不仅记载了华北板块与西伯利亚板块分而再合的历史, 留下了古蒙古洋板块扩张和消亡及其与古大陆碰撞对接过程的“印迹”, 而且产出了一系列金属矿床(点)(图版 I~VI), 为中亚巨型金属成矿带的重要组成部分。大量研究结果表明, 该区既是探讨中亚-蒙古巨型造山带演化历史的“天然实验室”, 也是寻找大型-超大型矿床的有利地域(李锦轶等, 2009; 聂凤军等, 2010a, 2010b, 2009, 2007, 2000; Badarch et al., 2002; MITM, 2002; 徐志刚, 1997; 王义天等, 2010)。

尽管地质学家在华北板块和西伯利亚板块运动机制的细节上仍存在有不同认识, 但是大家均承认, 南蒙古及邻区的主体构造为古大陆边缘地体拼接带。各单个地体形成环境和地质特征变化较大。它们可以是克拉通块体、变质岩块体或增生地楔, 也可以是岛弧带、弧前(或后)盆地和蛇绿岩带。与科迪勒拉、阿尔卑斯和喜马拉雅等典型造山带相比, 南蒙古及邻区具有下述几个特点: (1)蓝晶石-夕线石型区域变质岩带不甚发育; (2)同构造 S 型花岗岩分布范围有限; (3)磨拉石建造较为少见; (4)缺失造山带后期大规模 A 型俯冲和推覆构造; (5)造山带后期 A 型花岗岩分布广泛(徐志刚, 1997)。大量研究结果表明, 华北板块、古蒙古洋壳和西伯利亚板块之间的俯冲、碰撞、对接、拼贴和增

生是一个极为漫长和十分复杂的地质过程。

为了阐明这一地区大地构造单元时空分布特征和重塑地壳演化历史, 同时, 也为了全方位了解构造活动与成矿作用的成因联系, 许多地质学家在南蒙古及邻区开展了卓有成效的构造地质研究工作, 并且发表了一批重要的学术论著(李锦轶等, 2009; 聂凤军等, 2010a, 2010b, 2009, 2007, 2000; Badarch et al., 2002; MITM, 2002; 徐志刚, 1997)。这些研究成果对于提高本区的基础地质理论研究水平和推动找矿勘查工作顺利进行均发挥了重要作用。我们在野外调查工作基础上, 对前人所获各类构造地质和矿产地质资料数据进行了系统收集、整理和分析, 并且编制南蒙古及邻区矿产地质简图(图 1), 编图总体思路是, 以 Badarch et al.(2002)和李锦轶等(2009)所发表的资料数据为基础, 对中蒙边境地区的构造单元进行了对接, 目的旨在解决南蒙古成矿带的东、西方向延伸问题。与此同时, 我们对南蒙古及邻区产出的主要矿床(点)已有的资料数据进行系统梳理, 并且将所有的矿床(点)划分为 6 种类型, 即斑岩型、矽卡岩型、与深成侵入岩有关的热液脉型、火山岩型、沉积岩型和砂矿型(聂凤军等, 2010b, 2009; MITM, 2002)。另外, 在南蒙古及邻区, 特别是在中、蒙边境我国一侧圈定出 6 处矿化集中区, 这些矿化集中区大都由 3-5 处大、中型矿床组成, 并且显示出巨大的找矿潜力。从图 1 上, 人们至少可以获取以下 6 个方面的信息: (1)南蒙古及邻区主要矿

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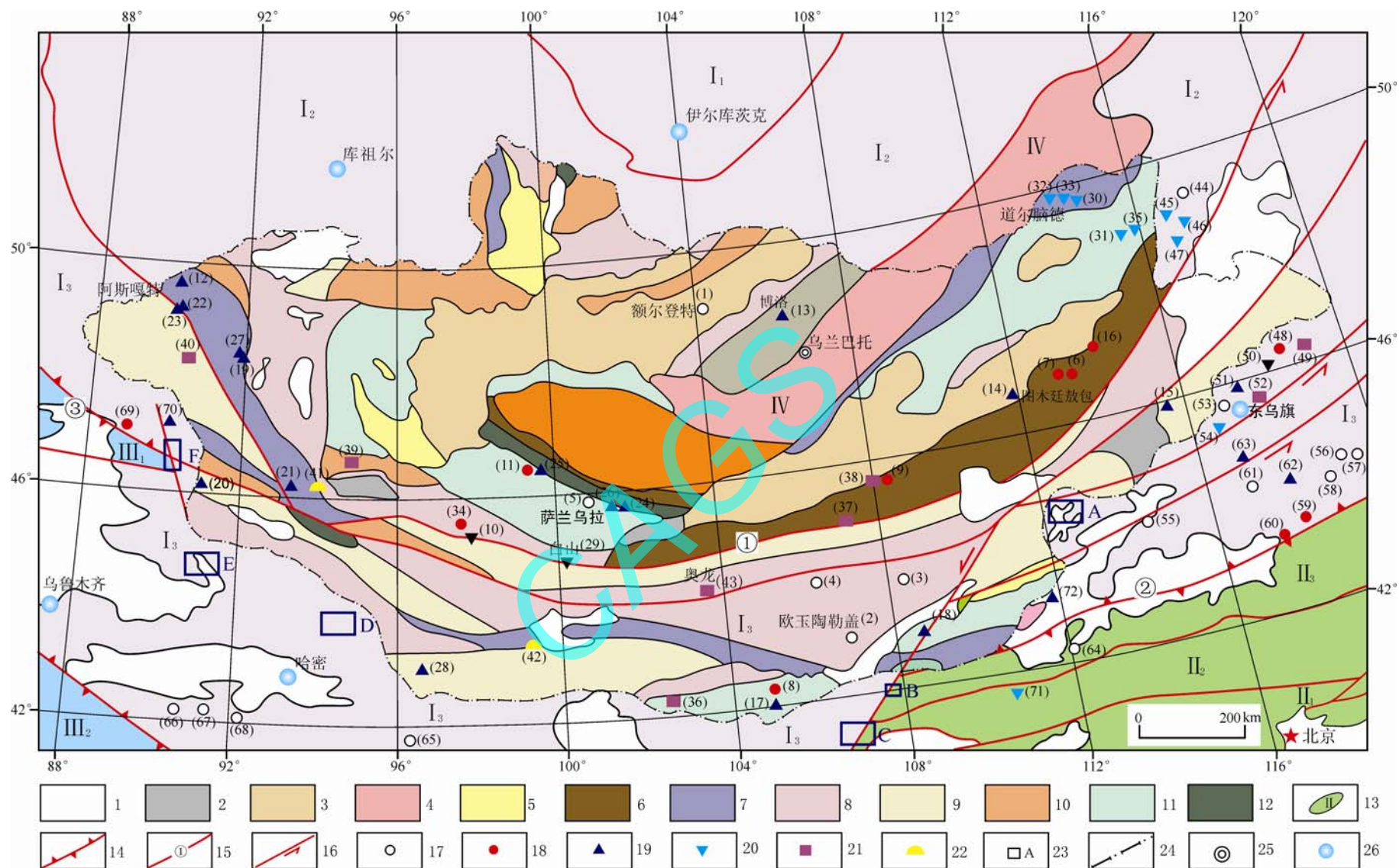


图 1 南蒙古及邻区构造地质和主要矿床分布简图(根据李锦铁等, 2009; Badarch et al., 2002; 和 MITM, 2002 资料数据改编) (说明见下页)

Fig. 1 Simplified tectonic map showing the distribution of major ore deposits in southern Mongolian and its neighboring areas (modified after Li et al., 2009; Badarch et al., 2002; MITM, 2002) (caption on the next page)

一般性图例(阿拉伯数字): 1-新生代冲积盆地; 2-新生代台地玄武岩; 3-二叠-三叠纪火山-深成岩带; 4-泥盆-石炭纪浊积岩盆地; 5-寒武纪大陆架碳酸盐; 6-被动大陆边缘古生界火山-沉积岩; 7-古生代增生地楔; 8-古生代岛弧火山-沉积岩; 9-古生代后弧/前弧火山-沉积岩盆地; 10-性质不明变质岩块体; 11-前寒武纪克拉通块体; 12-古生代蛇绿岩带; 13-大地构造单元及编号; 14-古板块缝合带; 15-深大断裂及编号; 16-大型走滑断层; 17-斑岩型矿床及编号; 18-矽卡岩型矿床及编号; 19-与深成侵入岩有关的脉状矿床及编号; 20-火山岩型矿床及编号; 21-沉积岩型矿床及编号; 22-砂金和铂矿床及编号; 23-矿化集中区及编号; 24-国界; 25-首都; 26-城、镇

General legends (Arab numerals): 1-Cenozoic alluvial basin; 2-Cenozoic plateau basalt; 3-Permian-Triassic volcano-plutonic belt; 4-Devonian-Carboniferous turbidite basin; 5-Cambrian shelf carbonate rocks; 6-passive continental margin 7- Paleozoic accretionary wedge ; 8-Paleozoic volcano-sedimentary rocks of island arc; 9- Paleozoic volcano-sedimentary rocks of backarc/fore arc basins; 10- Metamorphic rock belts with uncertain tectonic affinity; 11-Precambrian cratonic block; 12-Paleozoic ophiolite belt; 13-tectonic unit and its serial number; 14-Suture zone; 15-Deep-rooted fault and its serial number; 16-Large-size strike-slip fault; 17-Porphyry ore deposit and its serial number; 18-Skarn ore deposit and its serial number; 19-Vein type ore deposit related to pluton and its serial number; 20-Volcanic-type ore deposit and its serial number; 21-Sedimentary ore deposit and its serial number; 22-Palcer gold and PGE deposit and its serial number; 23- Mineralization concentrated camp and its serial number; 24-National boundaries; 25-Capital; 26-City or town

大地构造单元(罗马数字): -西伯利亚板块; 1-西伯利亚古陆核; 2-萨彦尔-贝加尔造山带; 3-准噶尔-南蒙古-大兴安岭造山带; -华北板块; 1-华北古陆核; 2-阴山-燕山造山带; 3-华北古陆北部增生边缘; -哈萨克斯坦板块; 1-塔尔巴哈台造山带; 2-乌拉尔-南天山造山带; -蒙古-鄂霍茨克造山带

In the aspect of tectonic unit (Roman numerals): -Siberian plate; 1-Old continental nuclei of Siberian plate; 2-Sayan-Baikal orogenic belt; 3-Junggar-Southern Mongolia-Da Hinggan Ling orogenic belt; -North China plate; 1-Old continental nuclei of North China plate; 2-Yinshan-Yanshan orogenic belt; 3-Northern accretionary margin of North China plate; -Kazakhstan plate; 1-Taerbahatai orogenic belt; 2-Ural-Southern Tianshan orogenic belt; -Mongol-Okhotsk orogenic belt.

深大断裂(圆圈内阿拉伯数字): -蒙古主要线性构造(MML); -恩格尔乌苏-索伦-西拉沐伦缝合带; -额尔齐斯-达拉布特-北天山缝合带

In the aspect of deep-rooted fault (Arab numerals in the circle): ①-main Mongolian lineament (MML); ②-Engerwusu-Sulinheer-Xar Moron suture zone; ③-Ertix-Dalabut-Northern Tianshan suture

主要矿床(点)(括号内阿拉伯数字): (1)-额尔登特铜(钼)矿床; (2)-欧玉陶勒盖铜(金)矿床; (3)-查干苏布尔加铜(钼)矿床; (4)-卡玛格泰金-铜矿化区; (5)-萨兰乌拉铜(钼)矿床; (6)-图木廷敖包钨矿床; (7)-萨尔西特锌矿床; (8)-哈尔陶勒盖银多金属矿床; (9)-奥尔特斯敖包锡矿床; (10)-洪戈赫铁多金属矿床; (11)-呼-布尔津-浑迪铜(金)矿点; (12)-阿斯嘎特银多金属矿床; (13)-博洛金矿床; (14)-布伦佐格特钨矿床; (15)-玉古兹尔钨(钼)矿床; (16)-阿林诺尔钨(铜)矿床; (17)-哈拉莫里图锡(钨)矿床; (18)-鲁金郭勒稀土元素矿床; (19)-哈尔扎-布尔格泰稀有(土)元素矿床; (20)-苏海特金矿床; (21)-呼尔曼诺尔金矿床; (22)-特松赫格钨矿床; (23)-乌兰乌拉钼(钨)矿床; (24)-罕乌拉金矿点; (25)-南部铜(金)矿点; (26)-塔特斯郭勒铜(钨、金)矿点; (27)-查干陶勒盖金矿床; (28)-塔林金矿点; (29)-白山铜-锌矿床; (30)-乌兰银多金属矿床; (31)-察干银多金属矿床; (32)-道尔脑德铀矿床; (33)-古尔万布拉克铀矿床; (34)-达吾克-柯哈金矿化点; (35)-沙尔黑特银多金属矿床; (36)-比鲁特敖包铜(铅)矿床; (37)-海耳罕铀矿床; (38)-哈拉特铜矿床; (39)-布尔吉铅(锌)矿床; (40)-呼阿达尔铜矿床; (41)-巴尔雷格高勒金矿床; (42)-乌赫础鲁特金-铂矿床; (43)-奥龙金矿床; (44)-乌努格吐铜(钼)矿床; (45)-甲乌拉银-铅-锌矿床; (46)-查干布拉根铅-锌-银矿床; (47)-额仁陶勒盖银多金属矿床; (48)-朝不楞铁多金属矿床; (49)-阿尔哈达铅-锌-银矿床; (50)-迪彦钦阿木钼-银矿床; (51)-沙麦钨矿床; (52)-吉林宝力格银-金矿床; (53)-奥尤特铜矿床; (54)-小坝梁铜(金)矿床; (55)-宝格达乌拉钼矿床; (56)-浩布高铅-锌-银矿床; (57)-敖脑达坝银-锡矿床; (58)-白音诺尔铅-锌矿床; (59)-大井银-锡-铜矿床; (60)-黄岗铁-锡矿床; (61)-毛登铜-锡矿床; (62)-拜仁达坝-维拉斯托银多金属矿床; (63)-白音查干银多金属矿床; (64)-白乃庙铜(钼、金)矿床; (65)-公婆泉铜多金属矿床; (66)-延东铜矿床; (67)-土屋铜矿床; (68)-赤湖铜矿床; (69)-索尔库都克铜(钼)矿床; (70)-喀拉通克铜-镍矿床; (71)-白云鄂博铁-铌-稀土元素矿床; (72)-苏莫查干敖包萤石矿床

In the aspect of mineral deposit (Arab numerals in the bracket): (1)-Erdentiin Ovoo Cu (Mo) deposit; (2)-Oyu Tolgoi Cu (Au) deposit; (3)-Tsagaan Suvarga Cu (Mo) deposit; (4)-Kharmagtai Au-Cu mineralized district; (5)-Saran Uul Cu (Mo) ore spot; (6)-Tumurtiin Ovoo Zn deposit; (7)-Salhit Zn deposit; (8)-Har Tolgoi Ag polymetallic deposit; (9)-Oortsog Ovoo Sn deposit; (10)-Khunkher Fe-polymetallic deposit; (11)-Huh Bulgiin Hundii Cu (Au) ore spot; (12)-Asgat Ag polymetallic deposit; (13)-Boroo Au deposit; (14)-Buren Tsogt W deposit; (15)-Yugur W (Mo) deposit; (16)-Ariin Nuur Mo (Cu) deposit; (17)-Har Morit Sn (W) deposit; (18)-Lugiin Gol REE deposit; (19)-Halzan Buregtei REE and rare metal deposit; (20)-Sukhait Au deposit; (21)-Khulman Nuur Au deposit; (22)-Tsunheg W deposit; (23)-Ulaan Uul Bi (W) deposit; (24)-Han Uul Au ore spot; (25)-South Cu (Au) ore spot; (26)-Taats Gol Cu (W, Au) ore spot; (27)-Tsagaan Tolgoi Au deposit; (28)-Talyn Meltes Uul Au ore spot; (29)-White Hill Cu-Zn deposit; (30)-Ulaan Ag-polymetallic deposit; (31)-Tsav Ag polymetallic deposit; (32)-Dornod (Mardai) U deposit; (33)-Gurwanbulag U deposit; (34)-Davkhyn Khar Au ore spot; (35)-Salhit Ag-polymetallic deposit; (36)-Biluut Ovoo Cu (Pb) deposit; (37)-Hairhan U deposit; (38)-Haraat U deposit; (39)-Boorj Pb (Zn) deposit; (40)-Huh Adar Cu deposit; (41)-Barlag Gol Au deposit; (42)-Uherchuluut Au and PEG deposit; (43)-Olon Owoot Au deposit; (44)-Wunugetu Cu (Mo) deposit; (45)-Jiawula Pb-Zn-Ag deposit; (46)-Chaganbulagen Pb-Zn-Ag deposit; (47)-Ereen Tolgoi Ag polymetallic deposit; (48)-Chaobuleng Fe-Bi-Zn deposit; (49)-Arhada Pb-Zn-Ag deposit; (50)-Diyangnamu Mo-Ag deposit; (51)-Shamai W deposit; (52)-Jilinbaolige Ag-Au deposit; (53)-Aoyoute Cu deposit; (54)-Xiaobaliang Cu-Au deposit; (55)-Bogda Uul Mo deposit; (56)-Haobugao Pb-Zn-Ag deposit; (57)-Aonaodaba Ag-Sn-Cu deposit; (58)-Baiyinnuo Pb-Zn (Cu) deposit; (59)-Dajing Sn-Pb-Zn-Ag deposit; (60)-Huanggang Sn-Fe deposit; (61)-Maodeng Sn-Cu deposit; (62)-Bairendaba-Weilasituo Ag polymetallic deposit; (63)-Bayanchagan Ag polymetallic deposit; (64)-Bainaimiao Cu (Mo, Au) deposit; (65)-Gongpuquan Cu polymetallic deposit; (66)-Yandong Cu deposit; (67)-Tuwu Cu deposit; (68)-Chihu Cu deposit; (69)-Suoerkuduke Cu (Mo) deposit; (70)-Kalatongke Cu-Ni deposit; (71)-Bayan obo Fe-Nb-REE deposit; (72)-Sumochagang Obo fluorite deposit

主要金属矿化集中区(从 A 到 F): A-洪格尔钼矿化集中区: 乌兰德勒、乌花敖包、达来敖包、准苏吉花和乌日尼图; B-乌尼图-查干花钼(铋、钨)矿化集中区: 查干花、查干德尔斯()、查干德尔斯()和查干础鲁图矿床; C-霍各乞-炭窑口铜多金属矿化集中区: 霍各乞、东升庙和炭窑口矿床; D-琼河坝铜、铁和金矿化集中区: 琼河坝铜矿床、蒙西铜(钼)矿床、绿石沟铜矿床、宝山铁矿床、北山金矿床和和尔赛铜矿床; E-双泉-库布苏金矿化集中区: 双泉、黄羊山西、苏吉泉、南明水和库布苏金矿床; F-卡拉先格尔铜-铁-金矿化集中区: 哈腊苏铜矿床、卡拉先格尔铜矿床、老山口铁-铜矿床、加乌特铁-铜矿床和科克萨依金矿床

In the aspect of mineralization concentrated camp (from A to F): A-Honggeer Mo camp: Wuladele, Wuhuaobao, Dalaiaobao, Zhunsujihua and Wurinitu deposits; B-Manitu-Chaganhua Mo (Bi, W) camp: Chaganhua, Chagandele (), Chagandele () and Chaganchulu deposits; C-Huogeqi-Tanyaokou Cu polymetallic camp: Huogeqi, Dongshengmiao and Tanyaokou deposits; D-Qionghaba Cu-Fe-Au camp: Qionghaba Cu deposit, Mengxi Cu (Mo) deposit, Lushigou Cu deposit, Baoshan Fe deposit, Beishan Au deposit and Heersai Au deposit; E-Shuangquan-Kubusu Au camp: Shuangquan, Huangyangshanxi, Sujiquan, Nanmingshui and Kubusu Au deposits; F-Kalaxiangeer Cu-Fe-Au camp: Halasu Cu deposit, Kalaxiangeer Cu deposit, Laoshankou Fe-Cu deposit, Jiamate Fe-Cu deposit and Kekeshayi Au deposit

床(点)的空间分布特征; (2)研究区的主要矿床(点)的类型; (3)主要矿床(点)与构造单元的空间分布关系; (4)南蒙古成矿带的东、西方向的延伸态势; (5)中蒙边境我国一侧主要矿床(点)在整个准噶尔-南蒙古-大兴安岭造山系中的位置; (6)在不同构造单元内, 找矿勘查工作的重点也应该有所不同。鉴于人们看问题的角度不同和采用的研究方法不完全一致, 因此, 对于上述矿产地质简图存在不同看法也是预料之中的事情。希望国内外地质同仁对南蒙古及邻区构造地质和矿产地质研究工作给予关注, 为在本区实现成矿理论研究和找矿勘查工作的“双突破”提出建设性意见。

参考文献:

- 李锦轶, 张进, 杨天南, 李亚萍, 孙桂华, 朱志新, 王励嘉. 2009. 北亚造山区南部及其毗邻地区地壳构造分区与构造演化[J]. 吉林大学学报(地球科学版), 39(4): 584-605.
- 聂凤军, 江思宏, 白大明, 侯万荣, 刘翼飞. 2010b. 蒙古国南部及邻区金属矿床类型及其时空分布特征[J]. 地球学报, 31(3): 267-288.
- 聂凤军, 江思宏, 白大明. 2010a. 蒙古矿产勘查与开发现状评述[J]. 地质论评, 56(1): 105-113.
- 聂凤军, 江思宏, 张义. 2007. 中蒙边境中东段金属矿床成矿规律和找矿方向[M]. 北京: 地质出版社, 1-574.
- 聂凤军, 江思宏. 2000. 中蒙边境塔林大型金矿化带的发现及对我们的启示[J]. 内蒙古地质, (2): 20-23.
- 聂凤军, 云飞. 2009. 蒙古国南部又发现一处大型铜-锌矿床[J]. 地球学报, 30(1): 127-128.
- 徐志刚. 1997. 大兴安岭及其邻区构造演化及控矿作用[M]. 赵一鸣、张德全主编, 大兴安岭及其邻区铜多金属矿床成矿规律与远景评价. 北京: 地震出版社, 1-21.

References:

- BADARCH G, CUNNINGHAM WD, WINDLEY BF. 2002. A new terrane subdivision for Mongolia: implications for the Phanerozoic crustal growth of central Asia[J]. J Asian Earth Sci., 20: 87-100.
- LI Jin-yi, ZHANG Jin, YANG Tian-nan, LI Ya-ping, SUN Gui-hua, ZHU Zhi-xin, WANG Li-jia. 2009. Crustal tectonic division and evolution of the southern part of the north Asian orogenic region and its adjacent area[J]. Journal of Jilin University (Earth Science Edition), 39(4): 584-605.
- Ministry of Industry and Trade, Mongolia(MITM). 2002. Mongolia: Investors' Forum 2002[C]. Internal Mining and Oil Industry Information Bulletin, 1-350.
- NIE Feng-jun, JIANG Si-hong, BAI Da-ming, HOU Wan-rong, LIU Yi-fei. 2010a. An Overview of Present Exploration and Exploitation on Mineral Resources of Mongolia[J]. Geological Review, 56(1): 105-113(in Chinese with English abstract).
- NIE Feng-jun, JIANG Si-hong, BAI Da-ming, HOU Wan-rong, LIU Yi-fei. 2010b. Type and temporal-spatial distribution of metal

deposits occurring in the Southern Mongolia, and its neighboring region[J]. Acta Geoscientica Sinica, 31(3): 267-288(in Chinese with English abstract).

- NIE Feng-jun, JIANG Si-hong, ZHANG Yi, BAI Da-ming. 2007. Metallogeny and ore Prospecting of ore deposits occurring along the border region of China and Mongolia[M]. Beijing: Geological Publishing House, 1-717 (in Chinese with English abstract).
- NIE Feng-jun, JIANG Si-hong. 2000. Discovery and its exploration significance of Talin Mettes Uul gold mineralized belt, South Mongolia[J]. Geology of Inner Mongolia, no.2 (Tot. 95): 20-23(in Chinese with English abstract).
- NIE Feng-jun, YUN Fei. 2009. Discovery of the White Hill copper-zinc deposit occurring in the southern Mongolia and its geological significance[J]. Acta Geoscientica Sinica, 30(1): 127-128 (in Chinese with English abstract).
- XU Zhi-gang. 1997. Tectonic evolution and ore-controlling factors of the Da Hinggan Mountains and its adjacent regions. In Metallogeny and prospective evaluation of copper polymetallic deposits in the Da Hinggan Mountains and its adjacent regions (editors: Zhao Yiming and Zhang Dequan)[M]. Beijing: Seismological Press, 1-21(in Chinese).

图版说明

图版 I Plate I

- 1 额尔登特铜(钼)矿山露天采场(由东向西看);
- 2 额尔登特铜(钼)矿山露天采场设备(由西向东看);
- 3 额尔登特铜(钼)矿床巨大的氧化型矿石;
- 4 额尔登特铜(钼)矿床代表性矿石;
- 5 额尔登特铜(钼)矿床角砾状矿石;
- 6 额尔登特铜(钼)矿床代表性矿石;
- 7 蒙古科布多省西部地貌特征;
- 8 蒙古巴彦乌列盖省西部雪山

- 1 Open pit of the Erdenet Cu-Mo mine (viewed from east to west);
- 2 Mining equipment in the open pit of the Erdenet Cu-Mo mine (viewed from west to east);
- 3 A huge oxidized ore in the Erdenet Cu-Mo mine;
- 4 Typical ore of the Erdenet Cu-Mo mine;
- 5 Breccia ore of the Erdenet Cu-Mo mine;
- 6 Typical ore of the Erdenet Cu-Mo mine;
- 7 Landscape of western Khovd Province in Mongolia;
- 8 The snow mountain in western Bayan-Olgii Province, Mongolia

图版 II Plate II

- 1 博洛金矿床采矿现场(左起古尔班、白大明、聂凤军

和江思宏);

- 2 博洛金矿山露天采场(由南向北看);
- 3 博洛金矿山选矿场一角(由西南向东北看);
- 4 博洛金矿山堆浸场一角(由西向东看, 右上方为生活区);
- 5 蒙古最大淡水湖-库苏古尔湖一隅(由北向南看);
- 6 蒙古最大淡水湖-库苏古尔湖渡假村(由南向北看);
- 7 蒙古吉尔吉斯湖正午风光(由北向南看);
- 8 蒙古吉尔吉斯湖傍晚风光(由北向南看);

- 1 Mining site of the Boroo gold deposit (from the left: GORBAN, BAI Da-ming, NIE Feng-jun and JIANG Si-hong);
- 2 Open pit of the Boroo gold mine (viewed from south to north);
- 3 Mill of the Boroo gold mine (viewed from southwest to northeast);
- 4 Heap leaching field of the Boroo gold mine (viewed from west to east, with the top light being the living area);
- 5 The largest freshwater lake in Mongolia—Lake Khovs Gol (viewed from north to south);
- 6 The resort in the Lake Khovs Gol, the largest freshwater lake in Mongolia (viewed from south to north);
- 7 The noon landscape of Lake Khyargas in Mongolia (viewed from north to south);
- 8 The sunset landscape of Lake Khyargas in Mongolia (viewed from north to south)

图版Ⅲ Plate III

- 1 对查干苏布尔加铜(钼)矿床进行野外地质调查(左起巴吉尔、江思宏、白大明、聂凤军和恩赫布仁);
- 2 查干苏布尔加铜(钼)矿床附近的白山头(由北向南看);
- 3 查干苏布尔加铜(钼)矿床矿化露头及探槽(由西向东看);
- 4 查干苏布尔加铜(钼)矿床斜井井口(由北向南看);
- 5 查干苏布尔加铜(钼)矿床矿化花岗岩地表露头;
- 6 查干苏布尔加铜(钼)矿床代表性网脉状矿石;
- 7 蒙古南部荒漠戈壁上的骆驼群(由西向东看);
- 8 蒙古南部荒漠戈壁地貌景观(由西向东看)

- 1 Field geological investigation in the Tsagaan Suvarga Cu-Mo deposit (from the left: BATJARGAL, JIANG Si-hong, BAI Da-ming, NIE Feng-jun and ENKHBUREN);
- 2 The white hill near the Tsagaan Suvarga Cu-Mo deposit (viewed from north to south);
- 3 Outcrop of mineralization and trench in the Tsagaan Suvarga Cu-Mo deposit (viewed from west to east);
- 4 The inclined well in the Tsagaan Suvarga Cu-Mo deposit (viewed from north to south);
- 5 Outcrop of the mineralized granite in the Tsagaan Suvarga Cu-Mo deposit;
- 6 Typical stockwork ore in the Tsagaan Suvarga Cu-Mo deposit;

- 7 A camel group in the Gobi Desert in southern Mongolia (viewed from west to east);
- 8 The landscape of the Gobi Desert in southern Mongolia (viewed from west to east)

图版Ⅳ Plate IV

- 1 对图木尔廷敖包锌矿山进行野外地质调查(左起、海軍、白大明、江思宏、聂凤军)
- 2 图木尔廷敖包锌矿山露天采场西段(由南向北看);
- 3 图木尔廷敖包锌矿床厚大的矿体露头;
- 4 图木尔廷敖包代表性矽卡型矿体露头;
- 5 萨尔西特锌矿床浅部矿化带探槽(由西向东看);
- 6 萨尔西特锌矿床代表性矿石样品;
- 7 与中蒙找矿勘查技术人员在野外进行地质调查(左起第二人为侯万荣、第三人为聂凤军);
- 8 野外地质调查工作中与蒙古孩童相遇(左起第三人为白大明、第四人为江思宏)

- 1 Field geological investigation in the Tumurtin Ovoo Zn mine (from the left: HAIJUN, BAI Da-ming, JIANG Si-hong and NIE Feng-jun);
- 2 West part of the open pit in the Tumurtin Ovoo Zn mine (viewed from south to north);
- 3 Outcrop of the thick ore body in the Tumurtin Ovoo Zn mine;
- 4 Outcrop of the skarn ore body in the Tumurtin Ovoo Zn mine;
- 5 Trench revealing the shallow mineralized zone in the Salhit Zn deposit (viewed from west to east);
- 6 Typical ore samples of the Salhit Zn deposit;
- 7 Field geological investigation with geologists from Mongolia (from the left: the second HOU Wan-rong, the third NIE Feng-jun);
- 8 Meeting with Mongolian children during field geological investigation (from the left: the third BAI Da-ming, the fourth JIANG Si-hong)

图版Ⅴ Plate V

- 1 查干查希尔金矿山远景(由南向北看);
- 2 查干查希尔金矿床含金石英矿体露头;
- 3 查干查希尔金矿床代表性矿石;
- 4 查干查希尔含金石英脉样品;
- 5 塔特斯郭勒钨-金矿床含矿角砾岩;
- 6 萨兰乌拉铜矿点矿化露头;
- 7 乌兰乌拉钨-金矿床地表采坑(由南向北看);
- 8 乌兰乌拉钨-金矿床代表性矿石样品

- 1 Distant view of the Chagan Chahir gold mine (viewed from south to north);
- 2 Outcrop of the gold-bearing quartz vein in the Chagan Chahir gold deposit;
- 3 Typical ores of the Chagan Chahir gold deposit;

- 4 Samples of gold-bearing quartz vein in the Chagan Chahir gold deposit;
- 5 Ore-bearing breccias in Taats Gol W-Au deposit;
- 6 Outcrop of mineralization in the Saran Uul Cu ore spot;
- 7 Surface mining pit in the Ulaan Uul W-Au deposit (viewed from south to north);
- 8 Typical ore specimen in the Ulaan Uul W-Au deposit

图版VI Plate VI

- 1 奥龙金矿床露天采场(由西北向东南看);
- 2 奥龙金矿床含矿浅变质岩地层露头;
- 3 奥龙金矿床含金石英脉样品;
- 4 奥龙金矿床含金蚀变岩样品;
- 5 白山铜-锌矿区代表性枕状玄武-安山岩露头;
- 6 白山铜-锌矿床代表性氧化型矿石样品;

- 7 白山铜-锌矿床代表性块状硫化物矿石样品;
- 8 白山铜-锌矿床代表性富铁铜-锌矿石样品;

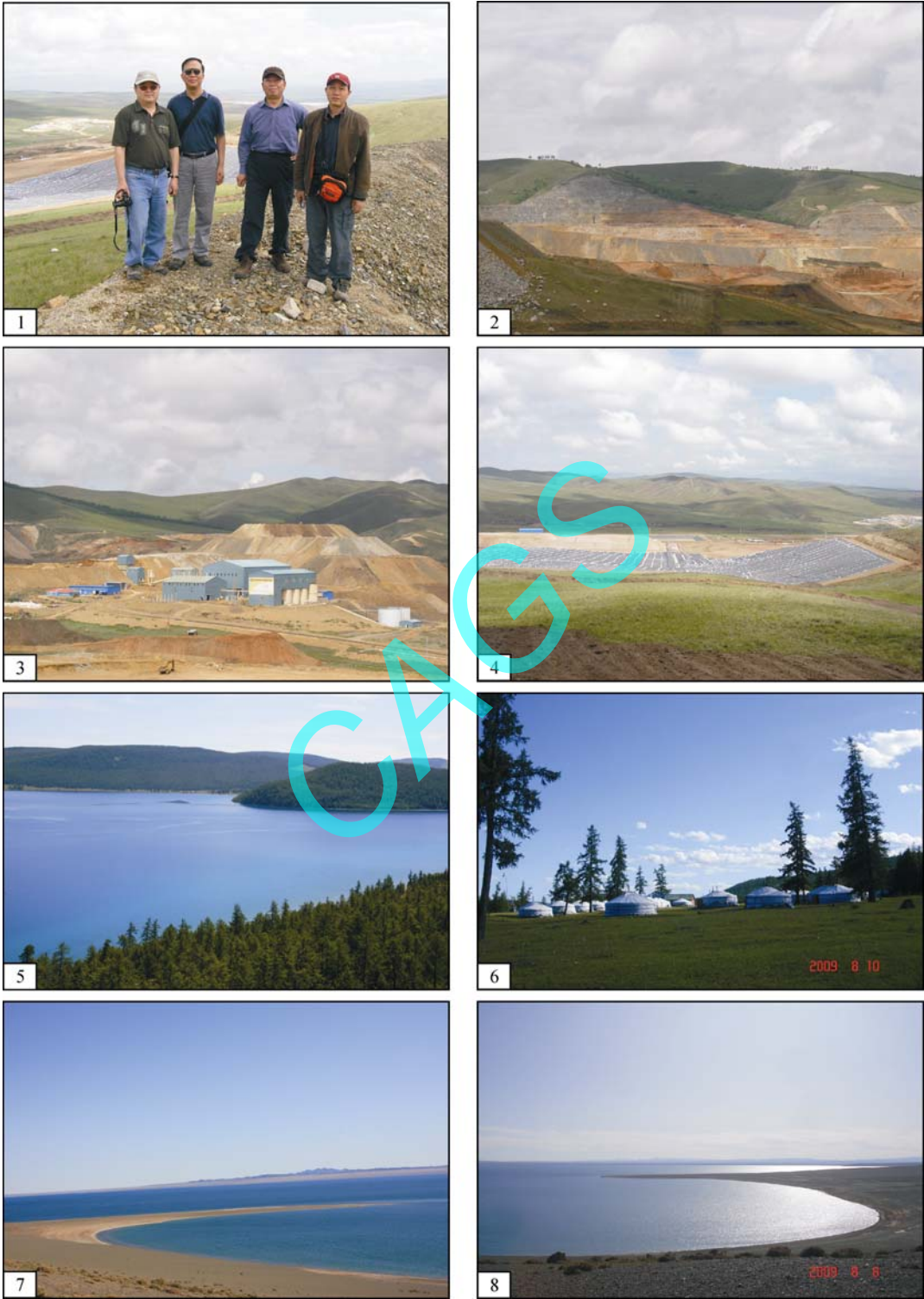
- 1 Open pit in the Olon Ovoot gold deposit (viewed from northwest to southeast);
- 2 Outcrop of epimetamorphic rocks in the Olon Ovoot gold deposit;
- 3 Specimen of gold-bearing quartz vein in the Olon Ovoot gold deposit;
- 4 Specimen of gold-bearing altered rocks in the Olon Ovoot gold deposit;
- 5 Outcrop of typical pillow basaltic andesite in the White Hill Cu-Zn deposit;
- 6 Typical oxidized ores in the White Hill Cu-Zn deposit;
- 7 Typical massive sulfide ores in the White Hill Cu-Zn deposit;
- 8 Typical iron-rich Cu-Zn ores in the White Hill Cu-Zn deposit

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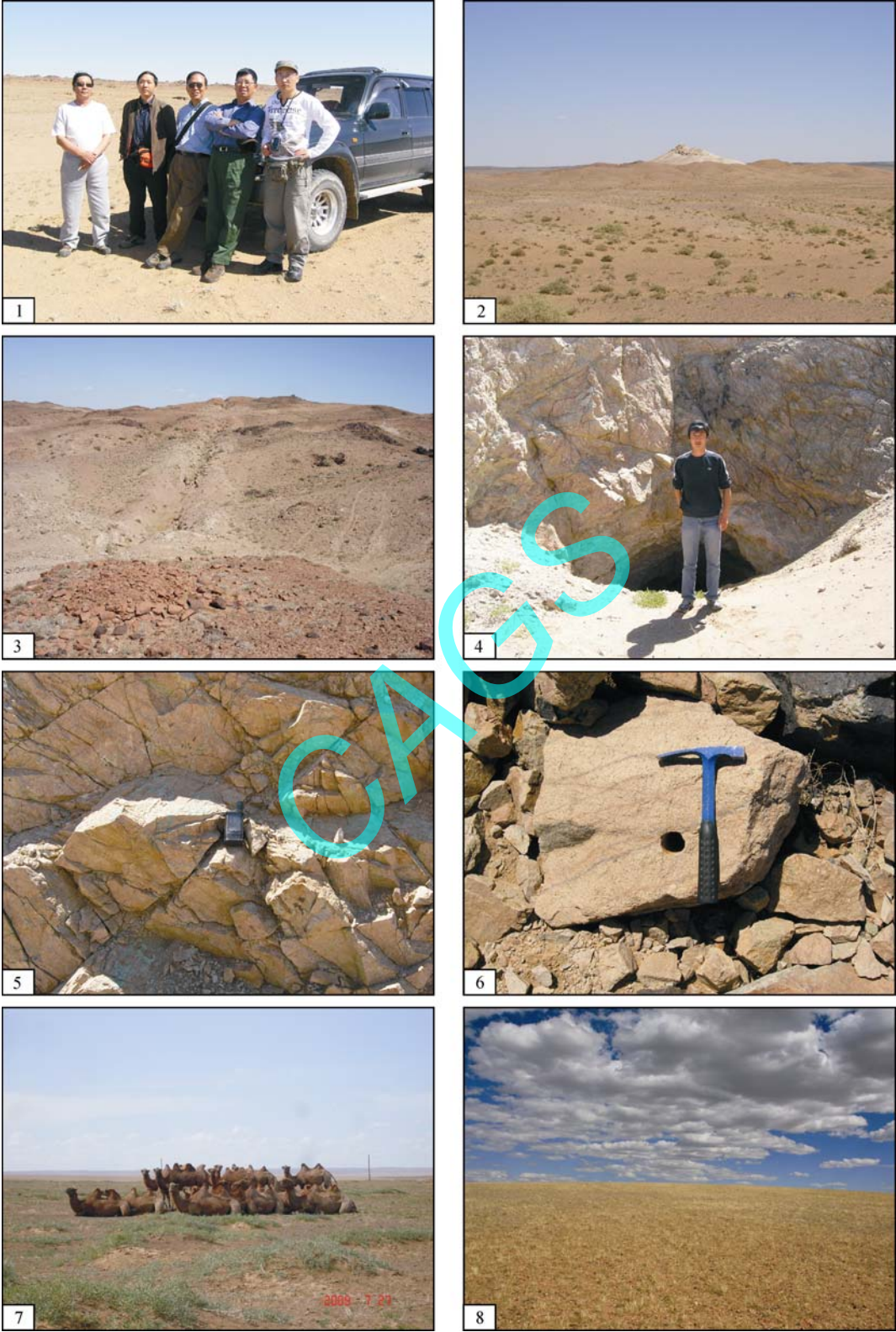
图版 I Plate I



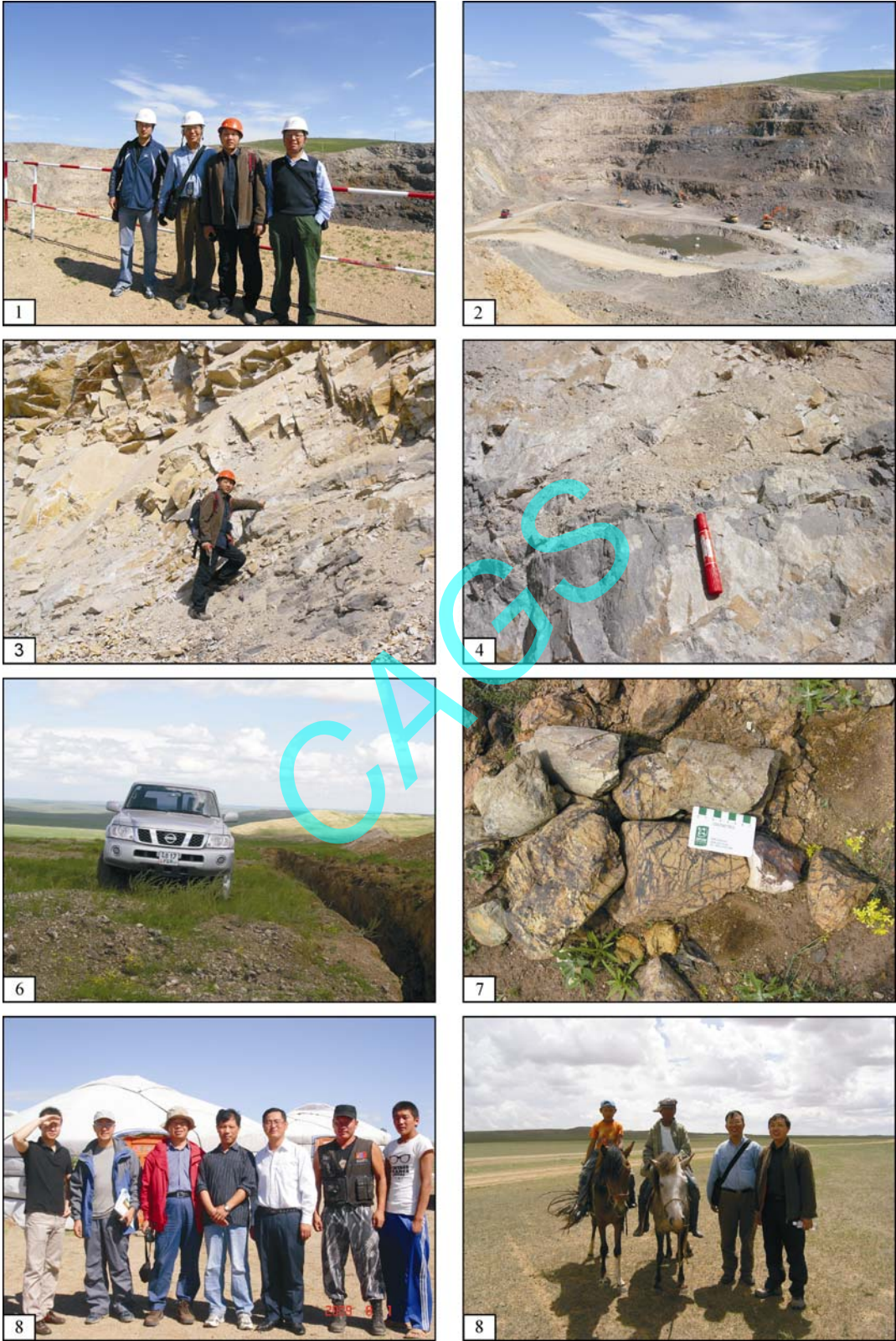
图版 II Plate II



图版Ⅲ Plate Ⅲ



图版IV Plate IV



图版 V Plate V



图版VI Plate VI

