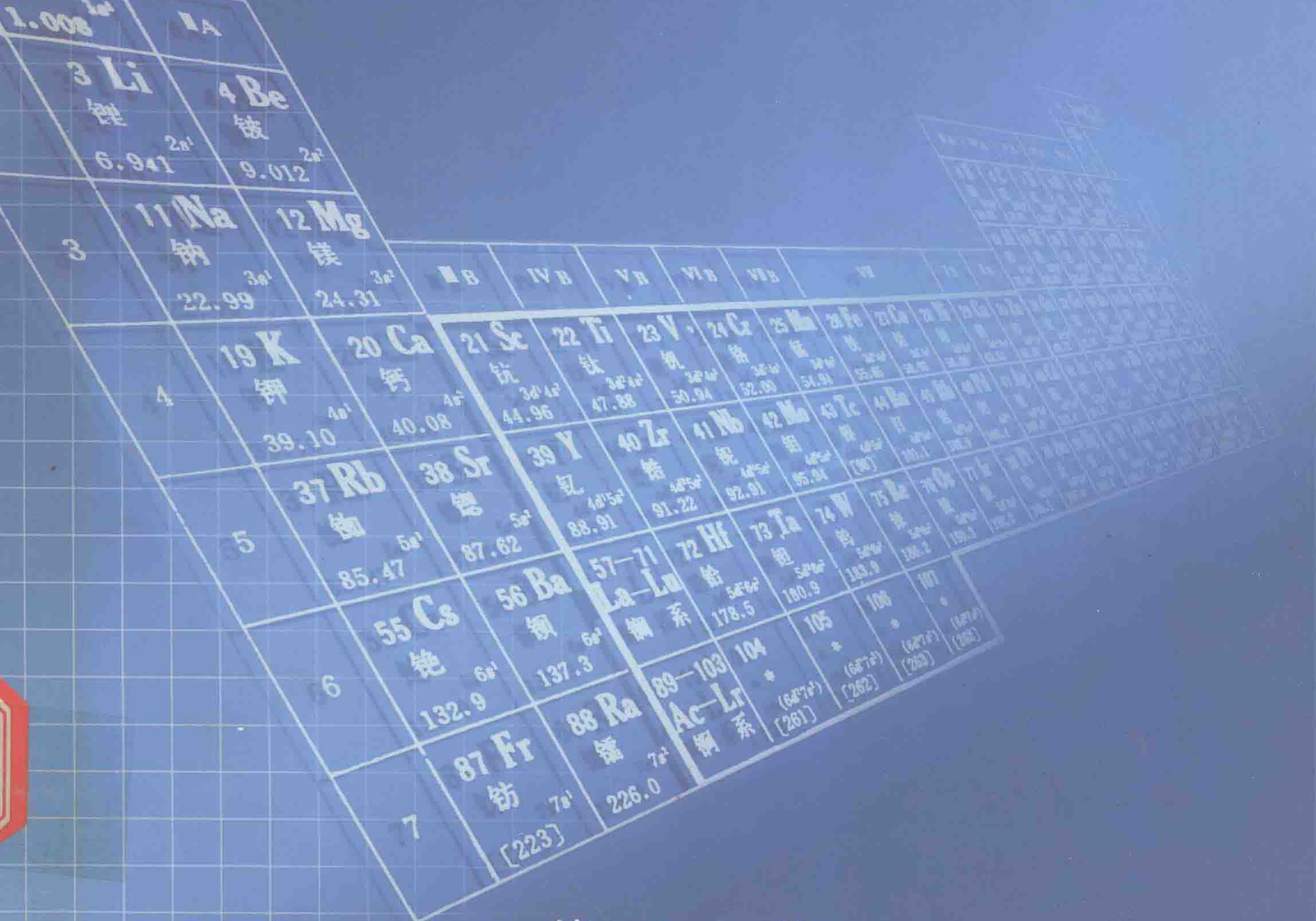
王毅民　高玉淑　韩慧明　王晓红　编著
Wang Yimin　Gao Yushu　Han Huiming　Wang Xiaohong

实用地质分析标准物质手册

Practical Handbook of Reference Materials for Geoanalysis



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（汉-英对照）

(Chinese-English)

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·北　京·

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内容提要

本书是一本实用标准物质手册。它收集了至2002年底国家公布的以地质类为主的国家一级标准物质（包括部分建材、环境和核材料标准）共计257种。

按不同使用目的编排成四种表格：综合信息表、特性值及相关参数表和两种特性值简表（分别按样品和元素顺序排列）。可按GBW号、样品名称和元素进行检索。为便于中、外交流，本书为汉英对照版。

地质标准物质已成为地质材料分析的重要技术基础，也是质量保证体系的重要组成部分。本书将成为标准物质研制，特别是地质、环境、建筑和核材料分析的广大测试人员及实验管理者必不可少的工具书，对从事分析化学、地球化学、环境化学科研人员和相关院校师生也同样有益。

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Foreword

Reference materials have a key role to play in any analytical laboratory. They are the principal means whereby the laboratory can demonstrate the traceability of analytical results. Not only does the use of reference materials play an important part in allowing analysts to ensure their analytical results are of the highest accuracy, they also are the most effective means of minimising inter-laboratory bias and in providing confidence to users of analytical data of the quality of the results they have been given to interpret.

One of the distinctive features of the chemical analysis of many types of sample is the need for matrix-matched reference materials. It is generally accepted that the most effective assessment of analytical performance can only be undertaken if there is a close match between the composition of the samples to be analysed and the reference materials used to validate the analytical results. It is particularly pleasing, therefore to be asked to introduce a compilation of results for the comprehensive range of certified reference materials produced in China. Not only are these samples of relevance to geoanalysts in China, they have found increasing application by the international community. I am certain this present compilation will be welcomed and find widespread use and particularly congratulate the foresightedness of the editors in publishing this compilation in a bilingual format.

Phil Potts
The Open University,
Milton Keynes, UK
March 2003

前　　言

标准物质(Certified Reference Material，CRM)是量值保存、传递和溯源的计量标准，是以物质或材料形式存在的计量器具。它是保证测量结果在时间、空间上的一致性和可比性的依据，在化学、生物、工程和物理等测量领域发挥着重要作用[1,2]。

化学成分测定属当今最广泛、最频繁的测量活动之一。化学成分测量大多不是直接测量，与大多数物理量检测相比，它的测定过程、环节要复杂得多，量值溯源也困难得多；当今大多数化学成分测定需要借助各类化学成分标准物质进行仪器校准、方法评价和质量监控。因此，化学成分标准物质的研制与应用是分析化学的一项重要研究内容和基础性研究工作。

地质材料是人类社会发展中最重要、最基本的原材料。它种类繁多、成分复杂，几乎涉及到自然界天然存在的所有元素，而且含量跨度达 10 多个数量级。因此地质分析(Geoanalysis)不仅是分析化学最古老、最广泛的应用领域，而且也是分析化学各应用领域中最复杂、最困难的任务之一，其分析结果的评价更强烈地依赖标准物质[3]。因此，地球化学标准物质(Geochemical Reference Material)或地质标准(Geostandards)已成为地质分析者必不可少的工具。地质分析者应像使用分析仪器那样，充分了解和熟练使用它们。

自从 20 世纪 50 年代初，美国地质调查所(USGS)等单位合作制备世界上首批地质标准物质 G-1 和 W-1 以来，地质标准物质的研制与应用工作在世界各国迅速发展。1977 年，“Geostandards Newsletter”创刊发行(从 1997 年开始拓宽为 Geostandards Newsletter：The Journal of Geostandards and Geoanalysis)并很快成为地质标准物质研制与应用最重要的交流园地[4~6]。随着地质标准物质种类与数量的快速增长，定期或不定期的地质标准物质汇编文献、专著和综述文章也日渐增多[7~11]。

我国地质标准物质的研制与应用工作虽然起步较晚，但发展极为迅速。二十世纪五六十年代我国地质部门虽也制备了一些类似于标准物质的实验室“管理样”，但真正意义上的地质标准物质还是从 1975 年中国地质科学院西安地质矿产研究所等单位合作研制两个超基性岩(DZΣ-1，2)和两个铬铁矿(DZCr-1，2)标准物质开始的。经我国地矿行业有关部门的共同努力，至今已形成种类比较齐全的地质材料成分分析标准物质体系。至 2002 年，由国家技术监督局(SBTS)批准公布的地质类国家一级标准物质已有 161 个，再加上建材、核材料、环境等类标准物质中的地质材料标准物质共计 257 个[12]。

地质标准物质的研制为这类材料分析质量保证体系的建立奠定了基础，也有力地促进了相关分析技术的进步。这些标准物质已在我国地矿、冶金、有色、建材、核工业、石油、农业、环境、商检和卫生等部门的分析质量监控、仪器校准、仲裁分析和方法评价中得到广泛应用并发挥了巨大作用[4,13]。

由于地质标准物质组成复杂、涉及的元素多、含量变化幅度大、分析难度大，新仪器、新方法用于地质标准分析的效果常成为该仪器或方法对复杂样品有效性和适应性的重要标志。因此这些地质标准物质在大型分析仪器评议和新分析方法研究评价中也得到了广泛应用[14]。

随着地质标准物质种类和数量的急剧增长，其应用技术也越来越复杂[1,15~18]。为了便于使用，国外早已有按应用需求编排的标准物质汇编或专著[7~11]。这些专辑(汇编)或专著中收录的我国地质标准物质数据较少(这与我国在国外刊物上发表地质标准物质数据较少或研制时较少采用国内外实验室协同定值有关)。前已指出我国已公布的地质分析用国家一级标准物质已超过 200 种，其中许多定值组分达六七十个。为了使我国地质分析者更好、更方便的应用这些标准物质，我们从有关标准物质证书及相关技术资料和公开文献提取了与应用有关的重要数据和相关信息，并参考国外有关工具书编辑了这

本实用手册[9~11]。手册采用了中、英文对照形式，便于与国外同行交流。可喜的是，在本手册编辑过程中韩永志研究员主编的两本标准物质手册问世[19,20]。据此，编者又对本手册中的有关资料进行了审核。本书在编写过程中得到了韩永志研究员、余逵高级工程师和许多研制单位及有关专家的大力支持，在此表示衷心感谢。特别感谢国际地质分析者协会(International Association of Geoanalysis，IAG)现任主席、英国开放大学教授、Potts 博士为本书作序。

由于我们水平和编写时间所限，不当之处，敬请指正。

编　者

2003 年 1 月于北京

Preface

Certified Reference Materials (CRMs) are metrological standards for maintaining and transferring values of a quantity and are traceable to primary standards. They can be considered as metrological standards that exist as substances or materials. They are used as the basis of assuring the consistency and comparability of measurement results in time and space, and play an increasingly important role in fields such as chemistry, biology, engineering and physics[1,2].

The determination of the chemical components of materials is one of the most frequently conducted measurement activities. However, few chemical components can be measured directly. Compared with most physical measurements, chemical determinations are more complicated in the processes and number of steps that must be followed, and hence pose greater difficulties in establishing the traceability of results. At present, calibrations of measuring instruments, evaluations of analytical methods, and quality assurance programmes all require RMs to validate determinations of chemical components. Consequently, the development and utilization of suitable RMs are of fundamental importance in analytical chemistry.

Geological materials, which comprise a wide range of matrix types and elemental compositions, are essential raw materials in contributing to the development of human society. They contain almost every element known to mankind, and the concentration of these elements can extend over more than 10 orders of magnitude. Geoanalysis is not only the oldest and most widely used application in analytical chemistry, but it also represents one of the most complex and toughest challenges in all fields of analytical chemistry. Furthermore, the evaluation of geoanalytical results depends to a great extent on the availability of suitable RMs[3]. As a result, Geochemical RMs or 'Geostandards' are indispensable to geoanalysts. Therefore, we should fully understand their metrological characteristics and correct use, just as we do in the operation of analytical instrumentation in our daily work.

Since the first geological RMs (G-1 and W-1) were prepared in a cooperative analysis programme involving the USGS and other institutions at the beginning of 1950's, research and utilization of geological RM's has developed rapidly all over the world. Geostandards Newsletter was first published in 1977 (later widened into Geostandards Newsletter: The Journal of Geostandards and Geoanalysis in 1997) and quickly became the most significant means of sharing and exchanging information about geological RM's and geoanalysis technology research[4~6]. Along with the substantial increase in the number of geological RM's available in terms of matrix type and the number of elements characterized, there has also been a corresponding increase in the number of compilations, monographs, review articles and other publications in this field[7~11].

Despite the late start in China, RM research and use has undergone a rapid development. Although the Central Geological Laboratories developed some "control samples" similar to RM's in 1950's and 1960's, the production of authentic geological RM only commenced when XIGMR of CAGS and other institutes co-developed two ultrabasic rocks (DZΣ-1, 2) and two chromitites (DZCr-1, 2) in 1975. Through the collaborative efforts of relevant geological and mineralogical departments and units, China has now established a comparatively complete suite of CRMs for the analysis of geological materials. Up to 2002, 161 geological CRMs have been authorized and approved by the State Bureau of Technical Supervision (SBTS). Together with geological CRMs of building and nuclear materials as well as environmental CRMs, there are now a total 257 CRMs in China[12].

The preparation and use of these geological CRM series has laid the foundation for a system of quality assurance in geoanalysis, and accelerated the development of related analytical techniques. These CRMs have been widely used and exerted a substantial impact in quality control, the calibration of instrumentation, arbitration analysis and the evaluation of methods in geology and mineralogy, agriculture, environment, commodity inspection, medicine and the metallurgical, non-ferrous metal, building material, nuclear and petroleum industries, as well as other areas[4,13].

Due to the complex matrix of geological RM, the large number of elements of interest, their large range of composition and the degree of difficulty in analysis, the success both of new instrumentation and new methods in the analysis of geological CRMs is often considered an important sign of their effectiveness and adaptability in analyzing complex materials. Therefore, geological CRMs are also widely used in the assessment of large analytical instruments and the evaluation of new analytical methods[14].

With the rapid increase in the number and type of RMs, their application in the assessment of techniques has become more and more complicated[1,15~18]. To simplify applications, compilations and monographs on geological CRMs were first published long ago in some other countries[7~11]. Unfortunately, these publications seldom include more than 200 different geological CRM developed in China, among which many have certified values that reach or exceed 60 to 70 in number. In order to help geoanalysts to use these CRMs effectively, we have compiled this manual by extracting relevant information from the published literature, RM certificates and other related documents, and by consulting relevant foreign reference books[9~11]. This manual has been designed as a Chinese-English bilingual handbook, convenient for communicating with foreign collaborators. We were very pleased that two RM manuals with prof. HAN Yongzhi as editor in chief came out whilst this manual was being compiled[19,20]. The information in this manual was again checked with the two manuals for accuracy and consistency. Finally, many thanks to Professor Han Yongzhi, Mr. Yu Kui, senior engineer and other people for their great support during the editing process of this manual. Especially, many thanks to Dr. P. J. Potts for the forward and the amendments to English manuscript of this book.

Editors
National Research Center of Geoanalysis
(Institute of Rock and Mineral Analysis,
Chinese Academy of Geological Sciences)
JAN.2003 in Beijing

目　　录

Content

1 列表及使用说明

1.1 样品收集范围

按照国家标准物质管理办法，我国的标准物质分为钢铁（GBW01）、有色金属（GBW02）、建材（GBW03）、核材料（GBW04）、高分子材料（GBW05）、化工产品（GBW06）、地质（GBW07）、环境（GBW08）、临床化学与医药（GBW09）、食品（GBW10）、能源（GBW11）、工程技术（GBW13）和物理学与物理化学（GBW13）13 大类。

当然这个分类并不十分严格，如地质成分分析标准物质中也有植物、人发等标准物质，而建材、核材料、环境等类标准物质中也有不少是典型的地质材料。另外随着地质研究领域的扩展，地质分析所涉及的材料范围越来越广。本手册仅收录由国家技术监督局（SBTS）公布的国家一级标准物质，所收集的样品类型除地质标准物质（GBW07）外，也包括了其他类型标准物质中的地质材料标准物质。电子探针、同位素和放射性标准物质将另做处理，暂未收入本手册。

1.2 各表的说明

为了适应使用中的不同查找方式，本手册编排了四种表格，分别说明如下：

★ 综合信息表：该表是所收集样品基本概况的总表，其栏目包括：序号（No.），国家标准物质编号（GBW No.），样品名称（s. name），材料类型和名称（t.&n. material），特性值总数，保证值数，参考值数，研制单位代码，页码和文献。

★ 定值数据及相关参数表：该表是按样品类型提供各样品的定值数据及相关参数的基本概况。它能为根据样品类型、特点和定值情况合理选择样品，提供更多信息。该表为本手册的主体，样品类型分为：

1. 岩石；2. 沉积物；3. 土壤；4. 矿石　矿物；5. 贵金属；6. 建材；7. 核材料；8. 环境。

该表的栏目有：组分、单位、测定组数、方法数、保证值或参考值（斜体）和标准偏差或不确定度。

★ 定值数据简表（按样品列出）：该表仅列出各样品的特性值并按前表中的样品分类集中排列。这种编排格式便于比较和了解各样品的特点，以利选择更合适的样品。

★ 定值数据简表（按元素列出）：该表是按组分（元素）给出各样品的特性值（从高到低的顺序）。根据特性值需求来选择相关样品时，使用该表更为快捷。表中组分（元素）出现的顺序是：先主、次量组分，后痕量元素。痕量元素的顺序，一般是按元素符号的字母顺序，但考虑到日常使用的习惯，稀土元素（REE）集中排列在一起；贵金属元素集中排列在其他痕量元素之后，这样更便于查找。

该表的栏目有：特性值、序号、GBW 号、样品名称。

1.3 符号及缩写

TFe	全铁
TFe_2O_3	全三氧化二铁
TMn	全锰
TS	全硫
C_{org}	有机碳
H_2O^+	正水（结构水）
LOI	烧失量
$fSiO_2$	可溶性 SiO_2
Σ	总量
▲	中位值

1 Instruction for tabulation and usage

1.1 Sample collection scope

According to "the Rule of Administrating Reference Materials" issued by the State Bureau of Technical Supervision (SBTS), Chinese CRMs are classified into 13 large categories: Steel (GBW01), Non-ferrous (GBW02), building Materials (GBW03), Nuclear Materials (GBW04), Macromolecule Materials (GBW05), Chemical Industry Produces(GBW06), Geology (GBW07), Environment (GBW08), Clinical Chemistry & Medicine (GBW09), Food (GBW10), Energy Resources (GBW11), Engineering Techniques (GBW12) and Physics & Physical Chemistry (GBW13).

Certainly, this classification is not exclusive. For instance, some RMs for geological component analysis contain plants and human hairs, whereas some RMs in other categories such as building material, nuclear material and environment samples are really typical geological materials. In addition, with the expansion of geological research, the scope of materials involved in geoanalysis is expanding as a consequence. This manual enlists only national CRMs first published by SBTS. Besides geological CRMs (GBW07), this manual also contains geological material CRMs in other CRM categories. Electron Microprobe, Isotope and Radioactive RMs are not included in this manual as they will be covered in separate publications.

1.2 Instruction of tables

In order to be adaptable to different search methods, this book is arranged with four types of tables, as follows:

★ Conprehensive information table: This is a general table of basic information of all listed CRMs. Information includes the serial number (No), the National Reference Material number (Chinese abbreviation GBW), sample name (s.name), type and name of material (t&n.material), total number of property value, number of certified value, number of proposed value, code of the supplier, page number and reference.

★ Property value and related parameter table: This table provides the basic information of the certification and related parameters of samples in accordance with sample types. It offers users more detailed information on the basis of different sample types, features and conditions of certification to assist in the choice of appropriate samples. Samples are divided into the following types:

1. Rock, 2. Sediment, 3. Soil, 4. Ore and mineral, 5. Noble metals, 6. Building materials, 7. Nuclear materials, 8. Environment samples,

The columns in this table include: component, unit, number of measured groups, number of methods, property value and standard diviation or uncertainty.

★ Property value short table (by sample): This table lists only the property value of elements in various samples according to the above mentioned sample types. This table is convenient for comparing and understanding features of various samples in order to select the most appropriate CRMs.

★ Property value short table (by element): This table gives property values of various CRMs according to different elements (by ascending order). Using this table is simpler and more direct when selecting CRMs on the basis of matching the property values of elements. The columns of the table include: property value (p.value), No., GBW No., and sample name (s.name).

1.3 Symbol and abbreviation

TFe	Total Iron	LOI	Loss of Ignition
TFe_2O_3	Total Fe_2O_3	$fSiO_2$	Soluble SiO_2
TS	Total Sulphur	Σ	Sum total
C_{org}	Organic Carbon	▲	mid-value
H_2O^+	Plus (combined or structural) water		

1.4 研制单位及代码 Suppliers and its code

代码 code	单位名称 suppliers	地址和邮编 address and post code	
AISGC	鞍山钢铁集团公司 Anshan Iron & Steel Group Corporation	辽宁鞍山市	114021
ASSGA	国家粮食局科学研究院 The Academy of Science of State Grain Administration	北京百万庄大街 11 号	100037
BIMRG	北京矿产地质研究所 Beijing Institute of Mineral Resources and Geology	北京黄寺大街 24 号	100011
BIUG	核工业北京地质研究院 Beijing Institute of Uranium Geology	北京安定门外小关东里	100029
BMEMC	北京环境保护监测中心 Beijing Municipal Environmental Monitoring Center	北京车公庄西路	100044
BRICEM	北京化工冶金研究院 Beijing Research Institute of Chemical Engineering and Metallurgy	北京通州区九棵树 145 号	101149
BUG	核工业总公司地质局 Bureau of Uranium Geology	北京高梁桥斜街	100081
CSIMG	中南冶金地质研究所 Central-South Institute of Metallurgical Geology	湖北宜昌市胜利一路 6 号	443003
GIFS	国贸食品科学研究所 Guomao Institute of Food Science	北京西城区百万庄大街	100037
GRIGNM	桂林有色金属地质研究院 Guilin Research Institute of Geology for Non-iron Metal	广西桂林三里店	541004
HEMC	黑龙江环境监测中心站 Heilongjiang Environmental Monitoring Center	哈尔滨市太平区 46 号	150056
IC	中国建材科研院水泥研究所 Institute of Cement, China Building Materials Academy	北京管庄东里 1 号	100024
ICUMR	郑州矿产综合利用研究所 Institute of Comprehensive Utilization of Mineral Resources	郑州伏牛路 26 号	450006
IEHE	中国预防医学科学院 环境卫生与卫生工程研究所 Institute of Environmental Health and Engineering Chinese Academy of Preventive Medicine	北京南纬路	100050
IG	国家建材局地质研究所 Institute of Geology, National Building Materials Bureau	北京东直门外南湖渠	100102
IGGE	地球物理与地球化学勘查研究所 Institute of Geophysical and Geochemical Exploration	河北廊坊金光道	102849
IMG	海洋地质研究所 Institute of Marine Geology.	山东青岛 18 号信箱	266071

代码 code	单位名称 suppliers	地址和邮编 address and post code	
IRMA (NRCG)	中国地质科学院岩矿测试所 (国家地质实验测试中心) Institute of Rock & Mineral Analysis, CAGS (National Research Center of Geoanalysis)	北京百万庄路26号 26 Baiwanzhuang Road Beijing 100037, China	100037
NRCEAM	国家环境分析测试中心 National Research Centre for Environmental Analysis and Measurement	北京育慧南路1号	100029
NRCRM	国家标准物质研究中心 National Research Center for CRM's	北京和平街11区7号	100013
NTCBM	国家建筑材料测试中心 China National Testing Center of Building Materials	北京管庄东里1号	100024
PISI	攀枝花钢铁研究院 Panzhihua Iron & Steel Institute	四川攀枝花	617067
QITR	中国烟草总公司， 青州烟草研究所 Qingzhou Institute of Tobacco Research	山东青州市香山路11号	262500
RCEE	中国科学院生态环境研究中心 Research Center of Ecological Environment Chinese Academy of Sciences	北京中关村北二条	100085
RIG	中化地质矿山总局地质研究院 Research Institute of Geology, China Chemical Geology and Mine General Bureau	河北涿州市范阳路72号	072754
SIGEC	沈阳综合岩矿测试中心 Shenyang Institute of Geological Experiment Center	辽宁沈阳北陵大街29号	110032
SIGE	山东地质科学实验研究院 Shandong Institute of Geological Experiment	山东济南历山路52号	250013
SINR	中国科学院上海原子能研究所 Shanghai Institute of Nuclear Research, Chinese Academy of Sciences	上海嘉定嘉罗公路2019号	201800
SIO	国家海洋局第二海洋研究所 Second Institute of Oceanography, State Oceanic Administration	浙江杭州1207信箱	310012
WIGEC	武汉综合岩矿测试中心 Wuhan Institute of Geological Experiment Center	湖北武汉利济北路246号	430022
WISC	武汉钢铁公司 Wuhan Iron & Steel Corporation	湖北武汉	430083
XIGMR	西安地质矿产研究所 Xian Institute of Geology & Mineral Resources	陕西西安市友谊东路166号	710054
YDITI	云南锡业设计院 Yunnan Design Institute of Tin Industry	云南个旧市五一路	661400

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