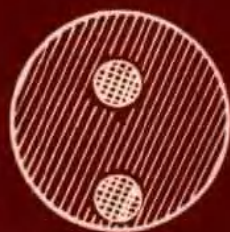


地震地球化学

廖卫华 李德方 廖卫华 著
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SEISMOLOGICAL GEOCHEMISTRY

蒋凤亮 李桂如 朱克文 著
王基华 张培仁

Jiang Fengliang, Li Guiru, Wang Jihua,
Zhang Peiren and Zhu Kewen

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内 容 提 要

本书是地球化学应用于地震预报研究和监测实践的经验总结。全书除介绍地震地球化学的理论基础外,着重介绍了地震地球化学中常用的监测方法,有很强的实用性。对从事地震监测预报、水文地质、石油地质勘探、地球化学找矿、环境化学以及分析化学等方面的科技工作者都有很大的参考价值。

ABSTRACT

This book is a summary of practical experiences in the geochemical approach to predicting and monitoring of earthquakes. The book centres on the conventional monitoring methods used in the seismo-geochemical field, beside their theoretical principles, which is of great practical significance and of great valuable reference to the workers who are devoted themselves to the monitor and prediction of earthquakes, study of hydrogeology, investigation of petroleum geology, geochemical survey of mines, environment chemistry and analysis chemistry.

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蒋凤亮等 编著

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说 明

地震地球化学是研究地震在孕育、发展、发生过程中化学元素的变化及迁移规律的科学。它是在近20年的地震预报研究和监测实践中逐步发展起来的一门新学科。

本书共分为两部分，第一部分着重介绍地震地球化学的理论基础；第二部分介绍地震地球化学中常用的监测方法，两部分由十三章组成，主要内容有：地震成因的地球内部物理化学机制；地下水质、水气、放射性元素和稳定性同位素的水文地球化学基础理论与地表前兆特征，同时还介绍了地球化学方法在研究活动断层中的应用。此外，书中特别收集了在地震地球化学中经常使用的各种测试方法。

本书是我国多年地震工作在地震地球化学研究实践中的经验总结，有很强的实用性，对从事地震地球化学、水文地质、石油地质勘探，地球化学找矿，环境化学及分析化学等方面的工作者都有一定的参考价值，也可以做为培养上述专业学生的参考书。

本书第一章、第八章、第九章、第十章由蒋凤亮执笔，第六章、第十三章由李桂如执笔，第四章、第七章、第十一章由王基华执笔，第二章、第三章由张培红执笔，第五章、第十二章由朱克文执笔，最后由蒋凤亮对全书进整理和修订。在编写过程中得到了高文学研究员，李宜璐高级工程师的指导和帮助并由他们对本书进行了最后审定。陶京玲同志为本书绘图和清稿。在此一并致谢。

鉴于编著者水平有限，本书难免有错和不当之处，敬请读者批评指正。

编著者

1988年10月

AUTHORS WORD

Geochemistry is a branch of science to study the variation of chemical elements and their systematic migration associated with the preparation, development and occurrence of the earthquakes, progressively developed in recent 20 years during which study of the prediction of earthquakes and their monitor has been carried out.

The book forms two parts, the first parts a stress on the seismogeochemical theoretical principles, the second, on the conventional method used in monitoring of seismogeochemical anomalies. The two parts consist of 13 chapters, mainly covering, physical and chemical mechanism in the internal earth for the generation of earthquakes, theoretical basis of hydrogeochemistry of groundwater quality, gases in water, radioactive elements and stable isotopes, and characteristics of their surface indications of an earthquake. Also presented in the book is the application of the geochemical approaches to the study of active faults. Meanwhile, specially collected here are various measuring methods usually used in this field.

The book is a summary of practical experiences in the seismogeochemical experiences in the seismogeochemical study that has been conducted in the recent past, which is of great practical significance and will serve as a valuable reference for professional workers who are devoted themselves to the study of this field and others mentioned in this abstract, and also for undergraduate and graduate students taking an introductory course in geochemistry. In this book Chapter One, Eight, Nine and Ten are written by Jiang Fengliang, Six and Thirteen by Li Guiru, Four, Seven and Eleven by Wang Jihua, Two and Three by Zhang Peiren, Five and Twelve by Zhu Kewen, final systematization and revision for the work is completed by Jiang Fengliang. Finally, we thank professor Gao Wenxue and highranking engineer Li Xuanhu for their kind direction and help as well as final examination of the work, we also thank comrade Tao Jingling for her excellent mapping and cleaning copy. By virtue of limited knowledge there must be some mistakes in this book, we sincerely expect some comments from readers.

Jiang Fengliang et al.

Oct. 1988

序 言

地震地球化学是近二十余年在地震实践中发展起来的一门新学科。从多次大震前兆表明,除了大量的地球物理场异常之外,还有大量的地球化学场的前兆特征。如在临震前,沿震源区的一些活动断层出现冒气现象,地下水变色变味、翻沙冒泡,同时并观测到了一些气体组分、放射性元素及某些离子浓度的变化等。这对捕捉地震前兆及提高地震预报水平是一种很有前景的手段之一。

目前地震地球化学在世界各国引起了有关学者的注意,苏联是世界上提出水文地球动力学前兆与水文地球化学前兆最早的国家,但大规模开展此项研究是1966年4月塔什干地震之后。我国在1966年3月22日邢台7.2级地震前后,发现了大面积的地下水翻花、冒泡和水苦甜变化等宏观现象。当时结合国内外地震史资料,在该地区开展了地下水氡、气体及水质的观测研究。积累了邢台余震水质组分变化的科学资料,获得了水化组分变化与地震关系的初步认识。随后在我国加强了此项工作的观测研究,在渤海7.4级地震、通海7.7级地震、炉霍7.9级地震、海城7.2级地震、龙陵7.6级地震、唐山7.8级地震及松潘7.2级地震等强震中取得了有关这方面的许多宝贵资料。近十余年来,日本、美国等世界许多国家也在这方面开展了大量的研究工作,并取得了一些成绩。

本书内容是著者多年工作经验的总结,同时收集了国内外有关这方面大量的资料。该书将震源区的物理化学过程中的一些地球化学、水文地球化学及地震地质紧密地结合起来,从理论到实践进行了叙述和探讨。同时对地下水中常量元素、微量元素、气体组分、放射性元素及稳定同位素的地震地球化学特征、测试技术与地震预报经验以及模拟试验进行了系统的叙述,并对断层气体及某些元素的地震地球化学特征进行了阐述。这对深入开展地震地球化学研究及地震预报具有重要的理论意义和实用价值。

该书不仅在地震预报研究中有重要意义,而且在石油勘探、地热开发、环境保护、地下水资源利用和分析化学等方面也有重要的参考价值。

高 文 学

1988年10月

PREFACE

Seismogeochemistry is a branch of discipline that has been developed in recent 20 years. The precursory phenomena of many earthquakes show that there exist a large number of characteristic precursors of the geochemical fields other than lots of anomalous geophysical fields. For instance, prior to an impending earthquake, such phenomena have been observed along some active faults in the hypocentral region as off-giving of the steam, changing of colour and odour of groundwater, overturning of sand and bubbling of water. Some components of gases, radioactive element, and concentration of some ions, and so forth have been observed as well. This is one of the most perspective tools for catching the earthquake precursors and raising the earthquake-predicting level.

For the time being, seismogeology has been paid attention by the investigators in this field in all over the world; Soviet Union is the earliest country that put forward the hydrogeodynamic and hydro-geochemical precursors for the earthquake prediction. And the research of this project was carried out after the Tashkent earthquake of Apr. 1966. Some macroscopic phenomena such as severe overturning and bubbling of groundwater, changing of the flavour of the well water were found following or preceding the $M=7.5$ Xingtai earthquake of Apr. 22, 1966. Observation and research was made of groundwater radon, gases and water quality at that time, along with collection of a large number of documents of historical earthquakes in the world. As a result, scientific data showing the variation of water components were accumulated for the Xingtai aftershocks and preliminary knowledge was obtained on the relationship between the variation in Hydrochemical components and the earthquakes, and, then observation and research has been enhanced. Plenty of valuable data of different kind have been obtained for strong $M=7.4$ Bohai, $M=7.7$ Tonghai, $M=7.0$ Luhuo, $M=7.2$ Haicheng, $M=7.6$ Longling, $M=7.8$ Tangshan and $M=7.2$ Songpan earthquakes.

In recent ten years or more, many countries, for instance, USA, Japan etc. have conducted a great deal of research in this field and made some progress.

This book is a summary of working experiences obtained for many years and collects a large number of data at home and abroad. The book links geochemistry, hydrogeochemistry and seismogeology together in the physical and chemical processes in the hypocentral region and then has them described and investigated, related to the theory and practice; also systematically stated are the characteristics of major elements, minor elements, gas components, radioactive elements and stable isotopes in groundwater, measuring technique, experiences of earthquake prediction and modelling experiments, as well as some characteristics of fault gases and seismogeochemistry for some elements. These are of significant practical values to making a thorough study of seismogeochemistry and earthquake prediction.

The book is not only of important significance to the study of earthquake prediction, but also of important valuable reference to surveying of petroleum, developing of geothermal sources, protecting of eco-environment, utilizing of subsurface water source and studying of analysis chemistry.

Gao wenxue

Oct. 1988

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