

GEOLOGICAL MEMOIRS

(Being the continuation of the Memoirs of the Geological
Survey to be quoted as Mem. Geol. Surv. China)

SERIES A, NUMBER 9.

THE GEOLOGY OF THE TSINLINGSHAN AND SZECHUAN (WITH 45 TEXTFIGURES, 19 PLATES AND ATLAS)

BY

Y. T. CHAO AND T. K. HUANG

Published by
THE GEOLOGICAL SURVEY OF CHINA

(Under the Ministry of Industries and affiliated
with the Academia Sinica)

AND

THE SECTION OF GEOLOGY OF THE NATIONAL ACADEMY
OF PEIPING

PEIPING, NOVEMBER, 1931

地質專報甲種第九號

趙亞曾
黃汲清 著

秦 嶺 山 及 四 川 之 地 質 研 究

中華民國二十年十一月

實業部直轄地質調查所
國立北平研究院地質研究所
印行

PREFACE

It has long been planned by Dr. W. H. Wong, Director of the Geological Survey of China, to re-investigate the geology of the Tsinlingshan, the backbone of China Proper. The idea would have long been put into realization but for the continual political disturbances. In the early spring of 1929 when peace was brought about Dr. Wong seized the opportunity and instructed Mr. Y. T. Chao and me to undertake the task. We left Sian on the 15th of March and reached Chengtu on the 22nd of June, spending three solid months in southern Shensi and northern Szechuan. From Chengtu we proceeded to Sūfu on the Yangtze River, making a rapid reconnaissance in central Szechuan. A detailed description of our itinerary is given in the introduction. On the 30th of October Mr. Chao left Sūfu and proceeded south-westward into Yunnan while I went directly south to Chên-hsiung-hsian. On the 15th of November Mr. Chao halted for the night at a place called Cha-sin-ch'ang near Chao-t'ung-hsian where he was attacked by a score of brigands and was murdered.

The death of Mr. Y. T. Chao is a great loss to geological sciences. To me it is a loss of a good teacher and friend. In the first months of our field work, I learnt much from Mr. Chao's method of work and profited greatly by his untiring advices and suggestions. For more than six months we marched through the wilderness of the Tsinlingshan, through the bandit-infested forests of the Tapashan, and through the numerous lofty ranges and deep river canyons in southern Kansu and northern Szechuan. If unaccompanied either one of us might have lost the courage to carry on the work through these inhospitable regions. One could realize the deep grief I felt when I received at Yung-ning-hsian in southern Szechuan the frightful news of his death.

With the death of Mr. Chao the task of writing the report of our survey falls on my shoulders. I realized it is a task not to be shirked. But inexperienced as I am, some of Mr. Chao's observations and ideas may have been incompletely recorded or even misrepresented. So I beg the reader to notice that though the field work was mostly done by Mr. Chao and myself together I am alone responsible for the imperfections of this memoir.

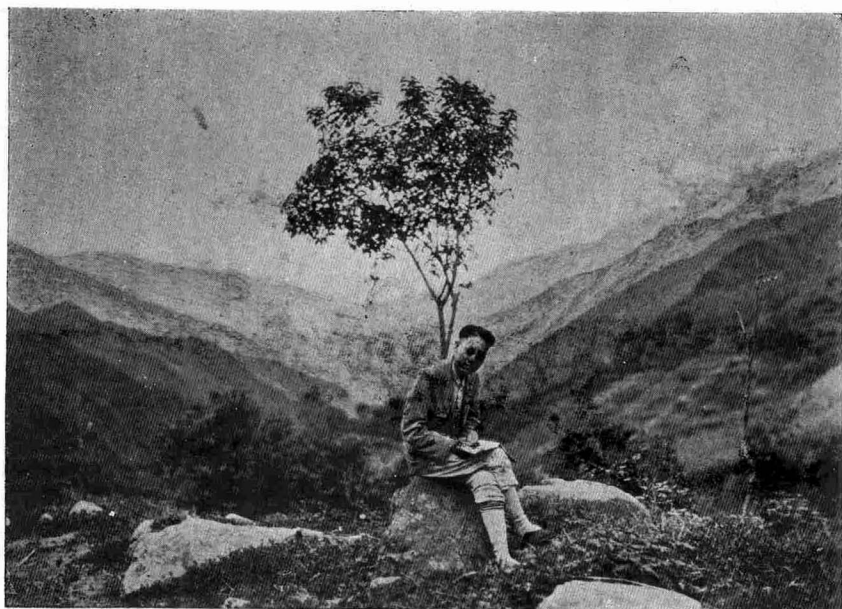
This memoir is divided into three parts. Part I records the actual observations and so is treated in a geographical order. Part II deals with systematic

geology and is arranged according to geological periods. Part III comprises brief descriptions of the mineral deposits in the regions traversed. Readers who do not have sufficient time to go through Part I are referred to Part II in which all our important conclusions and theoretical deductions can be found. The conclusions in the chapter on Stratigraphy are mainly the opinions of Mr. Y. T. Chao. The chapter on Geological Structure is written only after I have read the classical works of Richthofen, Loczy, Obrutcheff, Willis and others so I am responsible for the theories and deductions set forth. The chapters on Igneous Rocks and Physiography are likewise chiefly according to my own ideas. Had these chapters been written by Mr. Chao they would have appeared quite different except perhaps the chapter on Stratigraphy which would be essentially the same.

In the course of preparing this report Dr. W. H. Wong has given valuable suggestions and advices. Dr. V. K. Ting has also made helpful criticisms and it is by his wide experience in the geology of the southwestern provinces of China that I am able to get free from many false deductions regarding the geology of Szechuan. To Dr. George B. Barbour my heartiest thanks are due for his friendly criticisms and suggestions. In reading through my manuscripts Dr. Barbour has not only made valuable corrections for the style of the English but has also pointed out some doubtful conclusions in Part II which have been duly corrected. Dr. A. W. Grabau has kindly undertaken the description of the Devonian brachiopods collected by us and to him I am greatly indebted. To Dr. T. G. Halle I am also indebted for supplying me lists of the plant fossils and to Mr. C. C. Yü for his preliminary determination of the Carboniferous corals. To Mr. K. P. Chao I express my thanks for his kindness in furnishing me a geological section across the Tsinlingshan from Tzŭ-wu-k'ou to Shih-ts'üan-hsian. I also take this opportunity to thank Mr. S. C. Ts'ien, librarian of the Geological Survey, for valuable informations about the various maps consulted. All the maps and sections accompanying this book are drawn by Mr. S. Hou to whom I am under great obligations.

T. K. HUANG.

Peiping, July 23, 1931.



The late Mr. Y. T. Chao

Photographed at Mo-tzŭ-p'ing, S. Kansu.

趙亞曾君遺像

攝於甘肅南部磨子坪

GEOLOGICAL MEMOIRS

(Being the continuation of the Memoirs of the Geological
Survey to be quoted as Mem. Geol. Surv. China)

SERIES A, NUMBER 9.

THE GEOLOGY OF THE TSINLINGSHAN AND SZECHUAN (WITH 45 TEXTFIGURES, 19 PLATES AND ATLAS)

BY

Y. T. CHAO AND T. K. HUANG

Published by
THE GEOLOGICAL SURVEY OF CHINA
(Under the Ministry of Industries and affiliated
with the Academia Sinica)
AND
THE SECTION OF GEOLOGY OF THE NATIONAL ACADEMY
OF PEIPING

PEIPING, NOVEMBER, 1931

秦嶺山及四川之地質研究目錄

第一章 緒言

頁數

(一) 調查區域簡說	一
(二) 前人之調查	二
(三) 本屆調查經過	二
(四) 本書作成經過	四

第二章 地理

(一) 渭河流域 渭河 渭河之冲積平原 渭河谷傍之黃土台地	四
(二) 秦嶺山 名稱及範圍 秦嶺山之分水脊 秦嶺北坡 秦嶺南坡 南坡北坡之比較 秦嶺山脈中之名山	六
(三) 漢水流域 漢水及其支流 漢中盆地 漢渭二水間道路略考	十
(四) 大巴山	十五
(五) 嘉陵江及其支流 嘉陵江主流 白水 黃沙江 涪江	十五
(六) 岷江及沱江 岷江 沱江 成都平原	十七
(七) 四川赤盆地 名稱及範圍 盆地之地形 盆地中之山脈	十九
第三章 地層系統	二十一

(一) 舊寒武前紀 秦嶺系·····	二十一
(二) 震旦紀及寒武奧陶紀 柞水系 宜昌石灰岩 艾家頁岩及直角石灰岩·····	二十二
(三) 志留紀 石甕子石灰岩 新灘頁岩·····	二十三
(四) 泥盆紀 古道嶺石灰岩 江油系 肫駝寺板岩·····	二十四
(五) 石炭紀 略陽石灰岩 鎮安系·····	二十五
(六) 二疊紀 巫山石灰岩 草涼驛系 石炭二疊紀間之地殼變動·····	二十五
(七) 秦嶺之古代變質地層 岷江系 白水系·····	二十六
(八) 三疊紀 飛仙關系 嘉陵江石灰岩·····	二十七
(九) 侏羅紀 香溪煤系 滴水鋪系·····	二十七
(十) 白堊紀及始新統 四川系 東河礫岩 徽縣系 白堊紀前之地殼變動 始新統前之地殼變動·····	二十八
(十一) 上新統及洪積統 黃土 漢中壤土 赤盆地中之礫石·····	三十
附火成岩·····	三十一
(一) 花崗岩 漢南岩基 太白岩基 其他·····	三十一
(二) 其他侵入岩·····	三十二
(三) 侵入岩之時代·····	三十三
第四章 地質構造·····	三十三

(一) 秦嶺山之構造	摺曲	斷層	斷層之時代	南秦嶺與北秦嶺之劃分	三十三
(二) 大巴山之構造	摺曲	斷層			三十七
(三) 四川赤盆地之構造					三十八
第五章 經濟地質					三十九
(一) 金屬鑛產	秦嶺山中之鐵鑛	沙金	其他金屬		三十九
(二) 非金屬鑛產	煤	鹽煤油及煤氣	石膏		四十

秦嶺山及四川之地質研究

目錄

CONTENTS

Page

PART I. DESCRIPTIVE GEOLOGY.

CHAPTER I. INTRODUCTION.

General Geographic features	1
Itinerary	2
Method of Work.....	4
Geological Maps.....	5

CHAPTER II. IN THE EASTERN TSINLINGSCHAN.

Approaching Sian.....	9
From Sian to Chên-an.....	12
Physiographic Observations.....	23

CHAPTER III. IN THE WESTERN TSINLINGSCHAN.

From Sian to Pao-chi.....	27
From Pao-chi to Hanchung.....	28
Physiographic Observations.....	43

CHAPTER IV. IN THE UPPER HAN VALLEY.

The Environs of Hanchung.....	46
From Yang-hsian to Chên-pa.....	51
From Yang-hsian to Hua-yang-chên.....	55

CHAPTER V. FROM THE HANSHUI TO

THE CHIALINGCHIANG.

From Hanchung to Lio-yang.....	59
In the Western Tsinlingshan Again.....	63
From Lio-yang to Ch'ao-t'ien-chên.....	70
From Lio-yang via Tai-an-i and Ning-ch'iang to Ch'ao- t'ien-chên.....	73
From Ch'ao-t'ien-chên to Kuang-yüan.....	83

CHAPTER VI. IN NORTHERN SZECHUAN.

From Kuang-yüan to Ts'ing-ch'uan via Pi-k'ou.....	94
From Ts'ing-ch'uan to Mien-yang.....	100

CHAPTER VII. IN NORTH-WESTERN AND CENTRAL SZECHUAN.

In North-western Szechuan.....	106
In Central Szechuan.....	113

PART II. SYSTEMATIC GEOLOGY.

CHAPTER VIII. STRATIGRAPHY.

Early Pre-Cambrian.....	119
Tsinling System.....	119
Sinian and Cambro-Ordovician.....	128
Tsoshui Series.....	128
Ichang Limestone.....	132
Neichia Shale and Orthoceras Limestone.....	133
Silurian.....	133
Silurian of the Tsinlingshan—Shihwêngtzu Limestone..	134
Sintan Shale.....	134
Devonian.....	136
Devonian of the Tsinlingshan—Kutaoling Limestone...	136
Chiangyou Series.....	137
Pre-Devonian Diastrophism....	138
Kêtaszû Slate.....	139
Carboniferous.....	140
Lioyang Limestone.....	140
Chênan Series.....	141
Permian.....	143
Wushan Limestone.....	143
Permian of the Tsinlingshan.....	145
Ts'aoliangi Series.....	146
Permo-Carboniferous Diastrophism.....	147
Metamorphic Palæozoics of the Tsinlingshan.....	148
Minchiang Series.....	148

Pêshui Series.	150
Triassic.	152
Feisienkuan Series	152
Chialing Limestone	153
Jurassic	153
Süchiaho Series (Hsiangchi Series)	153
Mienhsian Series	154
Tishuip'u Series	155
Cretaceous and Eocene	158
Red Beds of the Red Basin of Szechuan--The Szechuan	
Series	158
Ts'ienfuyên Formation	160
Kuangyüan Formation	161
Ch'êngts'iangyên Formation	162
Tungbo Conglomerate	164
Huihsian Series	165
Pre-Cretaceous Diastrophism	166
Pre-Eocene Diastrophism	166
Pliocene and Pleistocene	167
The Northern Facies	167
Red and Reddish Clays	167
Sanmen Gravels and Calcareous tufa	168
Loess	168
The Southern Facies	170
Valley Loam of the Hanshui	170
Gravels of the Red Basin	170
Summary	171
CHAPTER IX. IGNEOUS ROCKS.	
Granite	173
Essential Characters of the Mesozoic Granite	173
Enumeration of the Larger Granite Bodies	173
The Hannan Batholith	174
The T'ai-pê Batholith	174
The Granite of Ning-shan-hsian	175
The Granite of Hua-yang-chên	175

Diorite	176
Gabbro	176
Diabase	176
Other Igneous Bodies	177
Distribution of the Igneous Rocks.	177
Geological Age	177
Summary.....	178

CHAPTER X. GEOLOGICAL STRUCTURE.

General Remarks.	179
I. Structure of the Tsinlingshan	179
Definition.	179
Prevailing Strikes and Dips.	179
Folds.	180
Anticlinoria and Synclinoria of the First	
Magnitude.....	181
Anticlinoria and Synclinoria of the Second	
Magnitude	184
Basins.	185
Faults	186
Normal Faults	186
Reversed or Thrust Faults	188
Date of Faulting.	189
Separation of the Northern and Southern Tsinlingshan .	189
II. Structure of the Tapashan	190
Definition	190
Prevailing Strikes	190
Folds	191
Anticlinoria.	191
Basins	192
Faults	193
III. Structural Independence of the Tapashan	196
IV. Date of Folding of the Tsinlingshan and Tapashan	197
Hercynian Movement	197
Yenshanian Movement	198

V. Broader Aspects of the Structure of the Tsinlingshan and Tapashan	200
VI. Structure of the Red Basin.	201
Nature and extent of the Red Basin	201
Folds in the Red Basin	203
Summary.	204

CHAPTER XI. PHYSIOGRAPHY.

I. Description of the Larger Geographic Features.	206
The Weiho and the Weiho Valley.	206
The Hanshui and the Basin of Hanchung.	207
Young Rivers in Northwest Szechuan.	209
The Chengtu Plain	210
II. Physiographic Stages	212

PART III. ECONOMIC GEOLOGY

CHAPTER XII. METALLIC MINERALS.

Iron Ore in the Tsinlingshan.	217
Placer Gold	218
Other Metallic Minerals	218

CHAPTER XIII. NON-METALLIC MINERALS.

Coal	219
Salt, Oil and Gas	221
Description of the Tzüliutsing Area	222
Other salt and oil-wells	227
Gypsum.	228

Note : Attention is to be directed to the errata at end of volume.

秦嶺山及四川之地質研究

趙亞曾 黃汲清 著

第一章 緒言

(一) 調查區域簡說

本屆調查區域範圍甚廣，計有陝西省舊關中道渭河流域之一部，舊漢中道之大部，甘肅省東南隅，四川省之北部及中部。調查區域地理的分劃比較甚爲簡單。最北爲渭河流域，地多平坦，渭水由甘肅來自西而東橫貫之。其南爲秦嶺山地，地勢崇高，峰巒層出，山路崎嶇，跋涉維艱，地土瘠瘠，物產不富。較之渭河流域之田疇千里，四通八達，向爲帝王建都立業之所者，實相形見絀也。秦嶺山地之南是爲漢水流域。漢水源出嶓冢，曲屈東流，至漢中附近成一雪茄烟形之小盆地，再東行經過低勢山嶺，至興安府復成一小盆地，再東則又入山地矣。故漢江流域除漢中興安二區外，均爲山嶺地帶，非若渭河流域之可極目無際也。惟是邦氣候甚佳，雨量豐富，林木幽深，種植之業亦甚可觀，非若渭河流域之亘年不雨者可比。蓋其地當秦嶺之南，地理形勢已入南方情況也。漢水流域與四川赤盆地之間山嶺叢出，總稱之爲大巴山區。是間峰巒峻秀，林壑幽深，大部尙爲未開闢之地。且地跨秦蜀二省，故常爲賊匪盤據，爲漢中及赤盆地之大患焉。大巴山東延與湖北西部山地及揚子江三峽地帶相接，西延至嘉陵江河谷而止。嘉陵江以西甘肅之南四川之北又另爲一山嶺地帶，中國地理書中常名之爲岷山。是帶地域地勢甚高，脈絡叢雜，山嶺均陡峻，平地絕少，甚不適於耕種。嘉陵江，白水，涪江及岷江由西北來貫穿之，河谷

秦嶺山及四川之地質研究