

**THE ORE MINERALS  
AND THEIR INTERGROWTHS**

**SECOND EDITION**

by

**PAUL RAMDOHR**

*Heidelberg*

**English Translation of the 4th Edition  
(with Additions and Corrections by the Author)**

**IN TWO VOLUMES  
VOLUME 1**

21774

# THE ORE MINERALS AND THEIR INTERGROWTHS

SECOND EDITION

by

PAUL RAMDOHR

*Heidelberg*

English Translation of the 4th Edition  
(with Additions and Corrections by the Author)

IN TWO VOLUMES  
VOLUME 1



PERGAMON PRESS

OXFORD · NEW YORK · TORONTO · SYDNEY · PARIS · FRANKFURT

**UK**

Pergamon Press Ltd., Headington Hill Hall,  
Oxford OX3 0BW, England

**USA**

Pergamon Press Inc., Maxwell House, Fairview Park,  
Elmsford, New York 10523, USA

**CANADA**

Pergamon of Canada, Suite 104, 150 Consumers Road,  
Willowdale, Ontario M2J 1P9, Canada

**AUSTRALIA**

Pergamon Press (Aust.) Pty. Ltd., P. O. Box 544,  
Potts Point, N. S. W. 2011, Australia

**FRANCE**

Pergamon Press SARL, 24 rue des Ecoles,  
75240 Paris, Cedex 05, France

**FEDERAL REPUBLIC  
OF GERMANY**

Pergamon Press GmbH, 6242 Kronberg/Taunus,  
Hammerweg 6, Federal Republic of Germany

---

Copyright © 1980 Akademie-Verlag Berlin

*All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means: electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise, without permission in writing from the publishers.*

First edition 1980

**British Library Cataloguing in Publication Data**

**Ramdohr, Paul**

The ore minerals and their intergrowths.

— 2nd ed. — (International series in  
earth sciences; vol. 35).

1. Ores

I. Title II. Series

553 TN 265 79-40745

ISBN 0-08-023801 7

Printed in GDR

## PREFACE

### TO THE SECOND ENGLISH EDITION

The present book will, with all probability, be the last edition revised by the author. Therefore, he asks permission to give some more remarks than those which are to a certain extent technical necessities for the preface of a textbook.

My books on ore microscopy have obviously inspired many interested scientists to investigate and to clear many questions. Certainly it turned out that not everything, which I thought to have obtained by my work and which I explained, was in all details correct. But that is a natural consequence of the progress in science. I, myself, have in such cases often taken up these questions again and reexamined, with three different results:

1. My statements were simply wrong — due to very varied reasons — or they could, many years ago, not be right due to the then imperfect methods and/or the too sparse material. The latter refers e.g. to the distinction between vallerite and mackinawite or to the complications in the system Ag-Sb between silver and dyscrasite and many others.

2. Other cases show that nature is often much more complicated than we assumed. One example are the Pb-Sb- or Pb-As-sulfosalts, where not only the actual compounds turned out to be much more numerous than anybody expected, but also the number of the components was greater. In addition — or perhaps in a certain opposition — there is now often an occurrence of solid solution with a broad spectrum of different properties complicating the definitions as well as the clear descriptions. Another problem is the “formula”, traditionally accepted to be stoichiometric, which they are often not at all. Many members of the niccolite group, e.g. are marked by the vacancy in “cation” sites, in the case of melonite varying between  $\text{NiTe}$  to  $\text{NiTe}_2$  — here apparently continuously — while in other cases — I doubt whether it is always justified — to assume a sudden alteration of the stoichiometry with often rather unlikely complicated members. One of these extreme cases is e.g. pyrrhotite. I hope, the reader will understand when I am not willing to agree to the “trend” of some colleagues to always create new names. Tiny splittings in the X-ray powder-diagrams can have essential meaning but it is not necessarily so.

A similar problem is the “anion deficiencies”, e.g. frequently occurring in minerals of the sphalerite and wurtzite structures and their relatives, even when not due to low partial pressure of S. To give a new name (or x names!) for a high-temperature chalcopyrite, which became cubic with principally the same lattice, and having lost a trace of S, and perhaps stabilized by a minimum content of Ni, is in my opinion completely unnecessary and in the consequence dangerous. Just in this group there exists a possibility of replacement or a further addition of other metal atoms as a result



of the very loosely packed ZnS lattice. Here we should not wonder, when as a result the lattice is distorted from cubic to tetragonal, to orthorhombic, to hexagonal etc. and/or it shows variations in space groups or polytypes. We should try first — even when we find it hard — to emphasize more the common properties of this group, and also many other more than the differences, since small variations in composition can go parallel with very distinct color deviations.

3. There is also a great number of new reports in literature, which apparently contradict my data or really do. The author could, of course, neither investigate all the deposits of the world, nor could he always get complete or in each case authentic material of all minerals — however in the course of his long life he worked hard in order to get at least a good general view. But it astonishes when the author is reproached for oversights, e.g. when somebody states that sphalerite stars in chalcopyrite are not a result of exsolution! I do not at all deny, that for one or the other reason these stars may occur somehow in similar form. However that exsolution is the rule can be proved by correct observations from more than 1000 deposits and laboratory experiments which can be carried out in a few hours! Some beginners put much more weight on statistics of two observations rather than on conclusions drawn from reliable statistics from 50 or 200!

Some discrepancy may derive from the overestimation of the experiment. — “Daraus schließt er messerscharf, daß nicht ist, was nicht sein darf” (From this he concludes “knife-sharp” that something cannot be which ought not to be!) But, nevertheless, it often is so! In dozens or perhaps hundreds of cases low-temperature compounds are known, which experimentally do not occur at all or only at normally intolerably long times of reaction. Vice versa, there are high-temperature minerals, which, in the experiments are absolutely instable below a certain temperature, become durable by tiny additions, and can also occur in nature. In metallurgy these are absolute trivialities. Expressions, such as “do not exist” should not be used at all, “could not be proved experimentally” only with the suggestion “in due time”, or “with the experimental apparatus which was at our disposal”. The author remembers a time when it was said that pyrite “could not be produced experimentally”. But once you know how to make it, it is not at all difficult to make pyrite! A long list of examples could be given.

The trend to give “data” which deliver foolproof right determinations has been developed e.g. since MURDOCH, DAVY and FARNHAM and SHORT, who tried in vain to get it by systematic etching, works now especially in two directions, indeed seeming to be extremely easy to recommend to the experienced observer:

1. The determination of hardness, at first as scratching-hardness (Talmage) and polishing-hardness, now especially as micro-hardness because it seemed to lead to quantitative accessible values.

2. The reflection-behaviour, already subjectively the most obvious characteristic, seems, regarding the modern highly developed methods, to be especially useful for quantitative data.

But both disappointed! The difficulties are here not caused by the technique of measurements but by the material itself: In the chemism where tiny, often almost trace-like components or likewise the pre-treatment can change the hardness completely. The same (in some cases at least) may happen very quickly with the reflection-behavior. In the polishing-technique e.g. already polishing in water or oil, polishing

under high or low pressure can cause varying micro-hardness but also the reflection behavior (mostly by differently strong or quick tarnishing) can be influenced considerably. The variability may also be caused by the difference between "real-crystal" and "idealcrystal", where it results in various but not at the first glance always visible properties: in the hardness getting higher or lower (compare the behavior of technically pure (99.5%) Zn with the so-called 5-nines Zn (99.999%). The reflectivity is mostly higher the nearer it comes to the ideal crystal. If e.g. out of these reasons UYTEN-BOGAARDT & BURKE give in their tables for a surely in hardness not strongly anisotropic and besides that in its chemism rather simple mineral, such as rammeisbergite, a Vicker's-hardness of 368-1048, then this proves clearly that such statements are not very useful and that it is not possible to call them "quantitative". A remark "differs in surprisingly wide data limits" would express much more. The figures of the measurement values might be alright — but when from these a "mean" is taken, this is really rather "risky".

In the reflection behavior we have the same problem. The measurements can be carried out much more accurately than they are significant for the object. We do not know all reasons, why the values vary so strongly already in the same section with excellent fresh polish and exactly the same method. Chances play perhaps the same part as the natural pre-treatment (shearings, recrystallizations) or lattice deficiencies or minute admixtures etc. When it is said from standards which have been used for a long time (not any more), e.g. galena or pyrite, that they have always and everywhere the same reflectivity (of course, only as long as they were not distinctly tarnished) then this was surely a mild self-delusion. With ideal conditions, from the same deposit and with material not being zoned, differences of 4 units in an intermediate reflectivity, i.e.  $> 8\%$  are not at all unusual. This seems to be small compared with the hardness-values but concerns in this medium range minerals showing strongly overlapping properties. Anyway, I think, the measurements of reflectivity may have a genuine chance in future if we compare statistical broadness (across the whole spectrum) — and if we are extremely careful! But today we are still very far from this goal.

For very uncommon minerals we should go again and again back to the powder-diagram and the microprobe. However, these too have their tricks. I mention powder-diagram on page 305, here only a few words on the microprobe. The microprobe or the microsonde, as it was first named by its inventor CASTAING, has given many valuable results, sometimes it has simplified the work greatly, but in many cases also shown that the facts are far more complicated than we at first assumed. — In spite of its invaluability it should not be forgotten, that the careful visual microscopic observation is still the primary! First of all, we must observe, that there is something to be seen at one place of the section, which is worthwhile for further investigation, then we can work with the microprobe!

Cases like the discovery of wairauite,  $\text{CoFe}$ , having been found accidentally during the investigation of awaruite and without any suspicion microscopically will, due to time and cost, remain rare exceptions. — Some publications of careful work with the microprobe has only proved things which were already known to BERZELIUS and GUSTAV ROSE some 150 or 120 years ago. On the other hand, there still remain many things much more worthwhile to be investigated.

Now some remarks on literature. It seems to be surprising that my list of literature still mentions very ancient papers. First of all, I think, that this is a matter of gratitude

A. B. EDWARDS, Parkside, Australia (†)  
G. M. FRIEDMAN, Troy, New York, USA  
G. FRIEDRICH, Aachen, Germany  
H. FROHBURG, Toronto, Canada (†)  
R. LA GANZA, North Adelaide, S. Australia  
W. F. HAEDERLE, La Oroya, Peru  
H. D. HOLLAND, Princeton, N.J.  
H. E. KAPP, Toronto, Canada  
H. KOBE, Auckland, New Zealand  
L. KOCH, Sydney-Kensington, Australia  
R. KOSER, Pullman, Washington  
G. KULLERUD, Lafayette, Indiana  
H. VAN DER LAAN, Delft, Holland  
B. F. LEONARD, Denver, Colorado  
G. J. NEUERBURG, Conifer, Colorado 80433  
E. H. NICKEL, Ottawa, Canada (now Perth)  
F. W. OSTERWALD, Denver, Colorado  
U. PETERSEN, Cambridge, Mass. U.S.A.  
G. M. RADISICS, Toronto, Canada  
J. RIMSAITE, Ottawa, Canada  
H. J. ROORDA, Delft, Holland  
C. B. SOLAR, Bethlehem, Penn.  
R. K. SOREM, Pullman, Washington  
R. G. WAYLAND, Arlington, Virginia  
G. WESTNER, Toronto, Canada  
A. W. G. WHITTLE, Parkside, S. Australia  
H. ZANTOP, Pullman, Washington (now Dartmouth College, Hanover, N. Hamp.)  
R. A. ZIMMERMANN, Heidelberg, Germany

To all these gentlemen I owe my sincere gratitude. Professor G. C. AMSTUTZ gave also some suggestions for the new edition. My friend and old pupil, Professor A. EL GORESY was so kind as to read the proofs with me and gave some helpful advices.

## ABBREVIATIONS

Abbreviations were avoided wherever possible, even despite the possibility of criticism. For physical and a few crystallographic data the conventional symbols are, of course, used.

$n_o$ or $n_o$ , $n_e$ or $n_e$	— main indices of refraction in uniaxial crystals (ordinary and extraordinary directions).
$n_\alpha$ , $n_\beta$ , $n_\gamma$	— main indices of refraction in biaxial crystals.
$R_o$ , $R_e$ , $R_o$ , $R_e$	— reflectivity of uniaxial crystals.
$R_g$ , $R_m$ , $R_p$	— reflectivity for biaxial crystals ("grand, moyen, petit"!).
$\kappa$ , or $\kappa_o$ , $\kappa_e$	— absorption index kappa.
#	— cleavage, or cleavage after . . .
<	— smaller than
>	— larger than
~	— approximately or similar
≈	— similar, but somewhat larger
∅	— on the average (or diameter)



# TABLE OF CONTENTS

## Volume 1

	Page
WRITER'S PREFACE TO THE SECOND ENGLISH EDITION	XVII
TRANSLATORS	XX
ABBREVIATIONS	XXII
INTRODUCTION TO THE GENERAL SECTION: INTERGROWTHS OF THE ORE MINERALS	1
GENETIC SYSTEMATICS OF ORE DEPOSITS	3
A. <i>Meteorites</i>	4
B. <i>Magmatic sequence</i>	4
I. Plutonic Rock series	5
(a) Intra-magmatic stage	6
1. <i>Magmatic differentiation through unmixing of fluids</i>	6
2. <i>Magmatic differentiation through crystallization</i>	7
3. <i>Main crystallization of silicates</i>	9
4. <i>Deposits formed by filter pressing</i>	12
(b) Pegmatitic-pneumatolytic stage	13
(c) Plutonic-hydrothermal deposits (veins, replacements, impregnations)	15
II. Subvolcanic Series	19
III. Extrusive sequence	20
C. <i>Sedimentary sequence</i>	23
I. Concentration of mechanically weathered materials	23
II. Enrichment processes in chemically weathered material	24
III. Precipitation of dissolved substances on the continents	24
IV. Precipitation of dissolved substances in the sea or in lakes and swamps	27
V. Deposits of coal and petroleum and of the materials genetically related to them	31
VI. The zone of oxidation and cementation	31
D. <i>Metamorphic sequence</i>	37
The metamorphism of ore minerals	37
I. General Aspects	37
II. Metamorphism through change in temperature and confining pressure	39
III. Metamorphism at high and highest pressures	47
IV. Metamorphism under the influence of directed pressure with or without essential influence of temperature changes	47

	Page
(a) General	47
(b) Application of the concept of "depth zones" of rock metamorphism to ores and ore deposits	77
(c) Minerals formed during serpentinization of ultrabasic rocks	79
<b>THE ORE TEXTURES</b>	
<i>Order of presentation</i>	81
<b>PRINCIPLES OF THE CLASSIFICATION OF THE ORE INTERGROWTHS</b>	82
<b>A. The fabric properties considered from a purely geometric point of view</b>	84
I. The properties of single grains	84
(a) Internal nature	84
(b) External grain properties	93
II. Intergrowths of several minerals	104
(a) Oriented intergrowths	108
(b) "Emulsion" textures	110
(c) Penetration textures	110
(d) Myrmekitic intergrowths	110
III. The forms of aggregates	123
(a) Arrangement in space	124
(b) Contact rims	129
(c) Mineral inclusions in ore minerals	134
IV. SCHNEIDERHÖHN's systematic classification of the structures and textures of the ores	137
<b>B. Genetic fabric types</b>	139
I. Texture of primary precipitation	139
(a) Growth fabric (crystallization from melts and solutions)	139
(b) Colloidal textures	144
(c) Sedimentary textures	157
II. "Transformation Textures"	162
(a) Paramorphs	163
(b) Exsolutions	165
(c) Decomposition structures	194
(d) „Verdrängung“ — "Replacement" — "Metasomatism"	194
(e) Thermal transformations	218
(f) Oxidation textures, and	218
(g) Cementation zone	218
III. Radioactive haloes, lattice destructions, blasting	231
Recognition of the genetic position of ore deposits	238
I. Typomorphic minerals, mineral assemblages, paragenetic sequences and fabric types	238
II. Ore minerals and ore associations as "geologic thermometers"	242
III. Relicts	250
IV. Further possibilities of genetic interpretation of textural characteristics	258
<b>C. The relationship of ore textures to industrial minerals and beneficiation problems</b>	263
<b>DESCRIPTIVE SECTION</b>	
Annotation concerning the arrangement of material in the descriptive section	283
I. General Data	284
II. Polishing properties	285

III. Reflection behaviour	290
IV. Etching	296
V. Physico Chemistry	299
VI. Fabric	299
VII. Special fabrics	302
VIII. Diagnostic features	303
IX. Paragenetic position	303
X. Investigated occurrences	304
XI. Literature	305
XII. Powder Diagram	305

## ELEMENTS AND INTERMETALLIC COMPOUNDS

Copper (+ Whitneyite)	308
Silver	313
Gold (Electrum)	321
Auricupride (AuCu, Goldeuprid)	334
Maldonite	336
Lead	337
Mercury (+ Kongsbergite and "Moschellandsbergite")	337
Schachnerite and Paraschachnerite	338
Palladium	338
Allopalladium, cf. Stibiopalladinite	339
Iridium	339
Platinum and Ferroplatinum	340
Osmiridium and Iridosmium	350
Newjanskite and Sysserskite	350
Iron ( $\alpha$ -iron) + Taenite	353
Awaruite (Josephinite, Souesite, Bobrovskite)	356
Wairauite	357
Cohenite — Cementite of Metallurgy	358
Schreibersite and Rhabdite	361
Native Nickel	362
Potarite	362
Tin	362
Niggliite	363
Sviagintsevite	363
Plumbopalladinite	364
Polarite	364
Stannopalladinite	365
Zinc	365
Native Arsenic	365
Arsenolamprite	370
"Allemontite"—Stibarsen	371
Antimony	373
Bismuth	374
Sulphur	381
Selenium	382
Tellurium	383
Graphite (+ Paragaphite)	384
Carlsbergite and Osbornite	392

## ALLOY-LIKE COMPOUNDS and TELLURIDES

Whitneyite, Algodonite, Domeykite	393
Cuprostibite	398
Kutinaite	398

Koutekite, Novakite, Horsfordite	Page 399
Dienerite, Orcelite	399
Oregonite	400
Mauchereite (Temiskamite, artificial „Nickelspeise“)	400
Hauchecornite	403
Parkerite	404
Shandite	405
Heazlewoodite	405
Dyscrasite and relatives (+ Allargentum)	407
“Dyscrasite of Cobalt”	413
Stibiopalladinite	414
Allopalladium	414
Rickardite	416
Weissite	419
Vulcanite	419
Melonite	420
Kitkaite	421
Imgreite	421
Hessite	421
Petzite	424
Fischesserite	425
Stützite and Empressite	425
Sylvanite („Schrifterz“)	426
Volinskyite	429
Kostovite	430
Krennerite (= Müllerine, Bunsenine)	430
Muthmannite	431
Calaverite	431
Nagyagite	433
Montbrayite	435
Tetradymite and Tellurobismutite (Tellurwismut)	436
Other Tellurium. — Bismuth compounds	438
Pilsenite (= Wehrlite) and Hedleyite	438
Joseite, Grünlingite, Oruetite	439
Temagamite	440

## Volume 2

COMMON SULPHIDES AND “SULPHOSALTS”	441
Chalcocite with Digenite, “rhombic chalcocite”, “cubic chalcocite”, Djurleite,	441
Anilite, “rose-gray chalcocite”	467
Berzelianite	468
Bellidoite	468
Oosterboschite	468
Umangite	469
Argentite-Acanthite	471
Naumannite (with Aguilarite)	478
Cacheutaite	478
Argyrodite and Canfieldite	479
Crookesite	481
Stromeyerite	481
McKinstryite	484
Eucairite	484
Betehtinite	486
Larosite	486
Jalpaite	486
Bornite, Peacock-ore of the miners	487

	Page
Pyrrhotite-group	592
Smythite	612
Eakebornite	612
Jaipurite	614
Freboldite	614
Niccolite	615
Langisite	623
Breithauptite	623
Westerveldite	625
Sederholmite	625
Modderite	625
Millerite	626
Mäkinenite	630
Cubanite	630
Sternbergite-Argentopyrite-Group	639
Sternbergite	641
Argentopyrite	641
Niningerite	642
Oldhamite	642
Alabandite	642
Iron-Alabandite	646
Galena	646
Clausthalite	659
Altaite	661
Miargyrite	662
Aramayoite	664
Schapbachite-Matildite	665
Herzenbergite and "Montesite"	669
Teallite	670
"Beegerite"	672
Cinnabar	673
Platynite	675
Covellite	676
"Permanent blue covellite"	679
Klockmannite	681
An introduction to Valleriite — Mackinawite	683
Valleriite	683
Mackinawite	683
Idaite	692
Braggite — Vysotskyite	695
Roseite	696
Cooperite	696
Linnaeite Group	697
Bornhardtite	702
Trüstedtite and Tyrrellite	703
Wilkmanite	703
Indite	703
Daubréeite	703
Brezinaite	704
Getchellite	704
Ottemannite	704
Antimonite, Stibnite	705
Metastibnite	709
Bismuthinite	710
Guanajuatite and Paraguanajuatite	714
Kermesite	715
Pavonite (Alaskaite)	716



# CONTENTS

XI

Chalcostibite (Wolfsbergite, Guejarite)	Page 717
Cuprobismutite	718
Emplectite	719
Junoite	721
Wittichenite	721
Klaprothite	722
Hodrushite	723
Regnolite	724
Epigenite	724
Berthierite	724
Histrixite	726
Smithite	726
Tapalpite	726
Stephanite	727
Polybasite and Pearceite	729
Lorandite	732
Vrbaite	732
Livingstonite	733
Seligmannite	734
Bournonite	734
Berthonite	738
Aikinite — Patrinite	738
"Rezbanite"	739
Hutchinsonite	740
Andorite, Ramdohrite, Fizelyite	742
Marrite	743
Freieslebenite	744
Brongniardite	745
Diaphorite	745
Owyheeite	745
Ultrabasite	746
Schirmerite	746
Benjaminite	747
Franckeite	747
Cylindrite	748
Preliminary remarks to the Pb-As-Sulfosalts, especially to the association Lengenbach, Binnental (Wallis)	750
Sartorite (Scleroclase)	750
Ustarasite	751
Baumhauerite	751
Liveingite ("Rathite II")	751
Rathite (Rathite I)	752
Dufrénoysite	752
Lengenbachite	754
Jordanite	754
"Guitermanite"	757
Gratonite	757
Pierrotite	759
Amorphous Hardened Sulfide Colloids ("Sulphide glasses")	759
Preliminary remarks to Pb-Sb-sulfosalts	760
Zinkenite	761
Füllöpite	762
Plagionite	762
Heteromorphite	763
Robinsonite	764
Semseyite	764
Jamesonite, "Federerz", in part, Heteromorphite, in part	765

	Page
Boulangerite and Falkmanite	770
Meneghinite	772
Geokronite (Kilbrickenite)	774
Preliminary remarks to the Pb-Bi-sulfosalts	776
Galenobismutite	777
Bonchevite	778
Cannizzarite	778
Weibullite	778
Cosalite (Bjelkite)	778
Bursaite	780
Kobellite	780
Heyrovskyite	781
Lillianite	781
Gustavite	782
Goongarrite (= Warthaite)	783
Lafittite	783
Routhierite	783
Proustite (Light Ruby Silver)	783
Pyrargyrite (Dark Ruby Silver)	785
Rittingerite and Pyrostilpnite	789
Samsonite	790
Pyrite	791
Melnikovite-Pyrite ("Colloform pyrite", crystallized $\text{FeS}_2$ gel)	806
Bravoite with Vaesite and Cattierite (Nickelpyrite, Hengleinite)	809
Villamaninite	816
Blockite ("Penroseite")	818
Trogtalite	819
Krutaite	820
Bambollaite	820
Laurite	820
Erlichmannite	821
Sperrylite	821
Aurostibite	824
Geverseite	825
Michenerite	825
Insizwaite	826
Froodite	826
Hauerite	826
Cobaltite	827
Gersdorffite	833
Ullmannite	836
Hollingworthite	838
Irarsite	838
Merenskyite, Moncheite, Kotulskite	838
Bukovite	839
Marcasite	839
Hastite	845
Ferroselite	845
Kullerudite	846
Safflorite-Löllingite-Rammelsbergite Group	846
Safflorite (Spatiopyrite)	847
Rammelsbergite	852
Löllingite	854
Frohbergite	858
Pararammelsbergite	860
Costibite	861
Paracostibite	861

	Page
Nisbite	863
Arsenopyrite (Mispickel)	863
Glaucodot	871
Gudmundite	872
Irsarsite and Osarsite	874
Molybdenite	874
Berndtite	880
Tungstenite	880
Skutterudite (with "Speiskobalt"-smaltite and chloanthite)	881
Patronite	887
Realgar	889
Dimorphite	890
Orpiment	890
Wakabayshilite	890
Duranusite	891
Voltzite	892
<b>OXIDIC ORE MINERALS</b>	893
Cuprite	893
Zincite	896
Manganosite	897
Wüstite	898
Tenorite (Melaconite)	899
Paramelaconite	903
Delafossite	903
Crednerite	906
Murdochite	906
Spinel	906
Galaxite	909
Preliminary remarks on the Ferrite-Spinel Family	910
Magnesioferrite	911
Magnetite	911
Ulvöspinel — Ulvite	923
Franklinite	940
Jakobsite and Vredenburgite	943
Chromite	946
Hausmannite	955
Hydrohausmannite, Hetairolite, Hydrohetairolite	958
Marokite	959
Bixbyite — Sitapelite	959
Braunite	962
Magnetoplumbite	966
Plumboferrite	967
Quenselite	967
Eskolaite	968
Karelinite	969
Hematite, Specularite, Oligiste	969
Ilmenite (with Geikielite and Pyrophanite)	980
Pseudorutile	997
Högbomite	998
Makedonite	1000
Maghemite	1000
Perovskite	1004
Davidite	1004
Rutile	1005
Ilmenorutile, "Strüverite"	1009
Anatase	1010

	Page
Cassiterite	1013
Plattnerite	1021
Preliminary remarks on Mn <sup>IV</sup> Oxides	1021
Polianite and Pyrolusite	1022
Polianite (sensu stricto)	1022
Pyrolusite (sensu stricto)	1025
Ramsdellite	1028
Nsutite ("Nsuta"-MnO <sub>2</sub> )	1029
Psilomelane and related minerals (Psilomelane in sensu stricto, cryptomelane, coronadite, hollandite)	1030
Hollandite	1035
Coronadite	1036
Lithiophorite	1038
Nolandite	1038
Columbite, Niobite-Tantalite	1039
Tapiolite	1042
Brannerite	1043
Pyrochlore Group	1046
Pseudobrookite	1046
"Armalcolite"	1047
Anosovite	1047
Kennedyite	1049
Baddeleyite	1049
Uraninite (Pitchblende, Nasturán, Uranpecherz)	1050
Thorianite	1070
Hydrous Iron Oxides	1070
"Nadeleisnerz (= Needle Iron Ore)", Goethite in American use	1071
Akaganéite = $\beta$ -FeOOH	1076
Ferrihydrite	1076
Lepidocrocite (Rubinglimmer, Germ.)	1076
Manganite	1079
Groutite	1081
Montroseite	1081
Heterogenite-Stainierite	1081
Woodruffite	1084
Todorokite	1084
Chalcophanite	1085
Wolframite	1087
Scheelite	1093
Ludwigite — Vonsenite	1094
Bonaccordite	1094
Hulsite-Paigeite	1095
Lievrite (Ilvaite)	1095
Coffinite	1097
<b>GANGUE MINERALS AND NON-OPAQUE OXIDE ORE MINERALS</b>	<b>1101</b>
Quartz	1102
Calcite	1103
Dolomite	1105
Siderite, Chalybite	1106
Rhodochrosite	1107
Smithsonite	1107
Cerussite	1108
Malachite and Azurite	1108
Barite (Heavy spar)	1109
Anglesite	1109
Fluorite (Fluorspar)	1110