Glossary of Uranium- and Thorium-Bearing Minerals
FOURTH EDITION
by JUDITH W. FRONDEL, MICHAEL FLEISCHER, and ROBERT S. JONES

A list of uranium- and thorium-containing minerals, with data on composition, type of occurrence, chemical classification, and synonymy

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GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS
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By Judith W. Frondel, Michael Fleischer, and Robert S. Jones

INTRODUCTION

The first edition of this work was published as U.S. Geological Survey Circular 74 in April 1950, the second edition as Circular 194 in February 1952, and the third edition in 1955 as U.S. Geological Survey Bulletin 1009-F. Research on radioactive minerals has grown in volume and scope, and this fourth edition, with its numerous additions, revisions, and corrections, brings the glossary up to date as of December 1966.

The compilation of this glossary is part of a continuing systematic survey of data on uranium and thorium minerals and on minerals that contain small amounts of uranium or thorium. This survey consists of collecting authoritative chemical, optical, and X-ray diffraction data from the literature and of adding to these data—where inadequate—by further laboratory research. The results obtained are published from time to time as separate papers, and a comprehensive volume on the mineralogy of uranium and thorium appeared in 1958 as U.S. Geological Survey Bulletin 1064.

The glossary is divided into three sections: A, minerals that contain uranium or thorium as a major constituent; B, minerals that contain minor amounts of uranium and thorium; and C, minerals that probably do not contain uranium or thorium, but which have been reported to contain impurities or intergrowths of uranium or thorium minerals. Many of the minerals listed are highly variable in composition, some varieties containing much, some little uranium or thorium. The known range of composition is listed for each, but the variability causes the division of species between A and B to be somewhat arbitrary. In the first and second editions of this glossary, a fourth group of nearly 40 minerals was listed as "Minerals That Should Be Tested for Uranium and Thorium"; these minerals had not been reported to contain uranium or thorium, but, on crystal-chemical grounds, they might be expected to show the presence of uranium or thorium if investigated.
by modern methods. This list is not included in the present edition, but many of those minerals have been added to section B as a result of additional studies.

In recent years careful studies have shown that many rock-forming minerals contain a few tenths of a part per million to a few parts per million of uranium and thorium. Data on these are not included; a summary is given by J. A. S. Adams, J. K. Osmond, and J. J. W. Rogers, "The Geochemistry of Thorium and Uranium." 1

It is hoped that this glossary will help to alleviate the confusion that obscures the nomenclature of the uranium and thorium minerals. For many of them, the confusion will remain until more thorough research is done. Some species may always be subject to question because their type specimens have been lost, and existing specimens bearing the species name have been found to be other minerals. For instance, in section A, uranochalcite (p. 45). The synonymy has been given for each species, but it is hoped that the many synonyms that serve no useful purpose will be abandoned. Identities and group relations are indicated. A chemical classification of the uranium and thorium minerals has been included, and very brief statements of the color of the minerals and the type of occurrence have been added.

It is beyond the scope of this publication to describe the minerals that are listed or to include determinative tables. Those interested are referred to the more comprehensive volumes listed below; and especially to "Systematic Mineralogy of Uranium and Thorium," by Clifford Frondel, U.S. Geol. Survey Bull. 1064, 400 p. (1958). For most minerals, the present publication generally gives references to recent papers or to abstracts of them in the American Mineralogist, or to standard reference books, especially to Dana's "System of Mineralogy." 2

Other major works on uranium and thorium are:


INTRODUCTION


The index of mineral names 534 entries. These represent 260 named species: 185 in section A, 55 in section B, and 20 in section C. Often the question is asked, “How many uranium and thorium minerals are there?” If section A is used as the criterion, there are about 185 such minerals to which 300 names have been applied.

We are indebted to many persons for suggestions and for pointing out errors in the previous editions, and we hope that readers will continue to inform us of any errors, omissions, or additional data.
CHEMICAL CLASSIFICATION OF THE URANIUM AND THORIUM MINERALS

Arsenates:
Abernathyite $\text{K}_2(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 6\text{H}_2\text{O}$
Arsenuranylite $\text{Ca}(\text{UO}_2)_4(\text{AsO}_4)_2(\text{OH})_4\cdot 6\text{H}_2\text{O}$
Hallimondite $\text{Pb}_2(\text{UO}_2)(\text{AsO}_4)_2$
Heinrichite $\text{Ba}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 10-12\text{H}_2\text{O}$
Hügelite $\text{Pb}_2(\text{UO}_2)_4(\text{AsO}_4)_2(\text{OH})_4\cdot 3\text{H}_2\text{O}$
Kahlerite $\text{Fe}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot n\text{H}_2\text{O}$
Metaheinrichite $\text{Ba}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 8\text{H}_2\text{O}$
Metakahlerite $\text{Fe}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 8\text{H}_2\text{O}$
Metakirchheimerite $\text{Co}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 8\text{H}_2\text{O}$
Metanovacekite $\text{Mg}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 4\text{H}_2\text{O}$
Meta-uranospinite $\text{Ca}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 8\text{H}_2\text{O}$
Metazeunerite $\text{Cu}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 8\text{H}_2\text{O}$
Novacekite $\text{Mg}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 8-10\text{H}_2\text{O}$
Paulite $\text{HAl}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 16\text{H}_2\text{O}(?)$
Sodium uranospinite $\text{(Na}_2, \text{Ca})(\text{UO}_2)_2[(\text{As, P})\text{O}_4]_2\cdot 5\text{H}_2\text{O}$
Troegerite $\text{H}_2(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 8\text{H}_2\text{O}$
Uranospathite $\text{Cu}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 11\text{H}_2\text{O}(?)$
Urbanospinite $\text{Ca}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 10\text{H}_2\text{O}$
Walpurgite $\text{Bi}_4(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 3\text{H}_2\text{O}$
Zeunerite $\text{Cu}(\text{UO}_2)_2(\text{AsO}_4)_2\cdot 10-12\text{H}_2\text{O}$

See also Unnamed minerals, p. 43–44.

Carbonates:
Andersonite $\text{Na}_2\text{Ca}(\text{UO}_2)(\text{CO}_3)_2\cdot 6\text{H}_2\text{O}$
Bayleyite $\text{Mg}_2(\text{UO}_2)(\text{CO}_3)_2\cdot 18\text{H}_2\text{O}$
Liebigite $\text{Ca}_2(\text{UO}_2)(\text{CO}_3)_2\cdot 10\text{H}_2\text{O}$
Mackelveyite Near $\text{Na}_2\text{Ba}_2\text{Ca}(\text{Y, U})_2(\text{CO}_3)_2\cdot 5\text{H}_2\text{O}$
Metazellerite $\text{Ca}(\text{UO}_2)(\text{CO}_3)_2\cdot 3\text{H}_2\text{O}$
Rabbittite $\text{Ca}_2\text{Mg}_2(\text{UO}_2)_2(\text{CO}_3)_2(\text{OH})_4\cdot 18\text{H}_2\text{O}$
Rutherfordite $\text{(UO}_2)_2\text{CO}_3$
Schroeckingerite $\text{NaCa}_4(\text{UO}_2)(\text{CO}_3)_3(\text{SO}_4)_2\cdot \text{F-10H}_2\text{O}$
Sharpite $\text{(UO}_2)(\text{CO}_3)_2\cdot \text{H}_2\text{O}$ or $6\text{UO}_2\cdot 5\text{CO}_2\cdot 7\text{H}_2\text{O}$
Studtite Hydrated carbonate of $\text{U}$ and $\text{Pb}$.
Swartzite $\text{CaMg}(\text{UO}_2)(\text{CO}_3)_2\cdot 12\text{H}_2\text{O}$
Thorbastnaesite $\text{Th(Ce, Ca)}(\text{CO}_3)_2\text{F}_2\cdot 3\text{H}_2\text{O}$
Voglite $\text{Ca}_2\text{Cu}(\text{UO}_2)(\text{CO}_3)_2\cdot 6\text{H}_2\text{O}$
Widenmannite Carbonate of $\text{U}$ and $\text{Pb}$.
Wyartite $\text{UO}_2\cdot 6\text{UO}_2\cdot 2\text{CO}_2\cdot 3\text{CaO}\cdot 12-14\text{H}_2\text{O}$
Zellerite $\text{Ca}(\text{UO}_2)(\text{CO}_3)_2\cdot 5\text{H}_2\text{O}$

See also Unnamed minerals, p. 42.

Molybdates:
Calcurmolite $\text{Ca}(\text{UO}_2)_3(\text{MoO}_4)_2(\text{OH})_2\cdot 11\text{H}_2\text{O}$
Cousinite $\text{MgO-2MoO}_4·2\text{UO}_2·6\text{H}_2\text{O}$

See also Unnamed minerals, p. 42.
Molybdates—Continued

Iriginite $\text{UO}_2\cdot2\text{MoO}_2\cdot3\text{H}_2\text{O}$

Morulanite $\text{UO}_2\cdot3\text{UO}_2\cdot7\text{MoO}_2\cdot20\text{H}_2\text{O}$

Mourite Hydrous uranous molybdate.

Sedovite $\text{U(MoO}_4\)_2(?)$

Umohoiite $(\text{UO}_2)(\text{MoO}_4)\cdot4\text{H}_2\text{O}(?)$

Wulfenite $\text{Pb(Mo, U)}_4$

Niobates-tantalates-titanates:

Aeschynite $(\text{Ce, Ca, Fe}^{+2}, \text{Th})(\text{Ti, Nb})_2(\text{O, OH})_8$

Betasite $A_{2-z}B_2O_4(\text{O, OH})_2$, where $A=\text{Ca, Na, U, Ce}; B=\text{Nb, Ta, Ti, Fe}$.

Brannerite $AB_2O_6$, where $A=U, \text{Ca, Fe, Th, Y}; B=\text{Ti mainly and Fe}$

Calciosamarskite Probably $(\text{Ca, Y, Ce, U, Th})_3(\text{Nb, Ta, Fe, Ti, Sn})_8\text{O}_{16}(?)$

Davidite $A_2B_4(\text{O, OH})_{36}$, where $A=\text{Fe}^{+3}$, rare earths, $U^{+4}$, $\text{Ca, Zr, Th}$; $B=\text{Ti, Fe}^{+3}$.

Euxenite $(\text{Y, Ca, Ce, U, Th})(\text{Nb, Ta, Ti})_2O_6$

Fergusonite $(\text{Y, Er, Ce, Fe})(\text{Nb, Ta, Ti})O_4$

Formanite $(\text{Y, U, Th, Ca})(\text{Ta, Nb, Th})_4$

Hielmite $(\text{Y, Fe, U})(\text{Nb, Ta, Sn, W})_2O_6$

Ishikawate $(\text{U, Fe, Y, Ce})(\text{Nb, Ta})O_4$

Kholopinite $(\text{Y, U, Th})_3(\text{Nb, Ta, Ti, Fe})_2O_6(?)$

Kobeite $AB_2(\text{O, OH})_6$, where $A=\text{Y, U}; B=\text{Ti mainly, Fe}^{+3}$, $\text{Nb, Ta}$

Loparite $(\text{Na, Ce, Th})_{1-z}(\text{Nb, Ta, Ti})[\text{O}_{5-z}(\text{OH})_z]$

Microlite $A_2B_2O_6(\text{O, OH, F})$, where $A=\text{Na, Ca, Fe}^{+2}$, $\text{U}^{+4}$, $\text{Sb}^{+3}$, $\text{Pb}$, $\text{Zr, Ce, Y}; B=\text{Nb, Ta, Ti, Sn, Fe}^{+3}$.

Niobo-aeschynite $(\text{Ce, Y, Ca, Fe, Th})(\text{Nb, Ti})_2O_8$

Nohlite $(\text{Ca, Mg, Fe}^{+2}, \text{Y, U})_3(\text{Nb, Zr, Fe}^{+3})_3\text{O}_{10}$

Obruchevite $(\text{Y, Na, Ca, U})(\text{Nb, Ta, Ti, Fe})_3(\text{O, OH})_7\text{H}_2\text{O}$

Pisekite Niobate-tantalate-titanate of $U$ and rare earths, with $\text{Th}$ and $\text{Sn}$.

Polycrase $(\text{Y, Ca, Ce, U, Th})(\text{Ti, Nb, Ta})_2O_6$

Priorite $(\text{Y, Er, Ca, Fe}^{+2}, \text{Th})(\text{Ti, Nb})_2O_4$

Pyrochlore $A_2B_2O_6(\text{O, OH, F})$, where $A=\text{Na, Ca, U, Th, Ce, Y}; B=\text{Nb, Ta, Ti}$.

Samarskite $(\text{Y, Ce, U, Ca, Fe, Pb, Th})(\text{Nb, Ta, Ti, Sn})_2O_6$

Sinicite $AB_2(\text{O, OH})_7$, where $A=\text{Ce, Y, Th, U}; B=\text{Ti, Nb}$ mainly

Thorutite $(\text{Th, Ca, U})\text{Ti}_2(\text{O, OH})_4$

Yttrocratesite $(\text{Y, Th, U, Ca})_2\text{Ti}_4\text{O}_{11}(?)$

Yttroantallate $(\text{Fe, Y, U})(\text{Nb, Ta})O_4$

Zirkelite $(\text{Ca, Fe, Th, U})_3(\text{Ti, Nb, Zr})_4\text{O}_7(?)$

Oxides:

Beccquerelite $7\text{UO}_2\cdot11\text{H}_2\text{O}$

Billietite $\text{BaO}\cdot6\text{UO}_2\cdot11\text{H}_2\text{O}$

Cerianite $\text{(Ce, Th)}_2O_3$

Clarkeite $(\text{Na, Ca, Pb, Th, H}_2\text{O})_3(\text{O, H}_2\text{O})_7$

Compreignacite $K_2O\cdot6\text{UO}_2\cdot11\text{H}_2\text{O}$

Curite $3\text{PbO}\cdot8\text{UO}_2\cdot5\text{H}_2\text{O}$

Fourmarierite $\text{PbO}\cdot4\text{UO}_2\cdot5\text{H}_2\text{O}$

Hydronasturan $\text{UO}_2\cdot k\text{UO}_2\cdot n\text{H}_2\text{O}$, where $k=2.3$ to $5.0$; $n=3.9$ to $9.0$

Ianthinite $\text{UO}_2\cdot5\text{UO}_2\cdot10\cdot11\text{H}_2\text{O}$

Masuyite $\text{UO}_2\cdot2\text{H}_2\text{O}$

Parapitchblende Oxide of uranium, chiefly $\text{U}^{+6}$, minor $\text{U}^{+4}$. 
CHEMICAL CLASSIFICATION

Oxides—Continued

Richetite Contains Pb and U.
Schoepite \( \text{UO}_2 \cdot 2\text{H}_2\text{O} \)
Thorianite \((\text{Th}, \text{U})\text{O}_2\)
Uraninite \( (\text{U}^{+++} - x, \text{U}^{++} + x)\text{O}_2 + x \)
Uranosphaerite \( \text{BiUO}_4(\text{OH}) \)
Urgite \( \text{UO}_2 \cdot \text{nH}_2\text{O} \)
Vandenbrandeite \( \text{CuUO}_2 \cdot 2\text{H}_2\text{O} \)
Vandendriesscheite \( \text{PbO} \cdot 7\text{UO}_2 \cdot 12\text{H}_2\text{O} (?) \)
Wölsendorfite \( (\text{Pb}, \text{Ca})\text{U}_2\text{O}_7 \cdot 2\text{H}_2\text{O} \)

See also Unnamed minerals, p. 43.

Phosphates:

Autunite \( \text{Ca}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 10 - 12\text{H}_2\text{O} \)
Bassetite \( \text{Fe}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O} \)
Bergenite \( \text{Ba}(\text{UO}_2)_4(\text{PO}_4)_4(\text{OH})_4 \cdot 8\text{H}_2\text{O} \)
Brockite \( (\text{Ca}, \text{Th})\text{PO}_4 \cdot 2\text{H}_2\text{O} \)
Cerophosphorhuttonite \( (\text{Th}, \text{Ce})((\text{Si}, \text{P})\text{O}_4 \cdot 1.5\text{H}_2\text{O} \)
Cheralite \( (\text{Ca}, \text{Th}, \text{Ce})(\text{P}, \text{Si})\text{O}_4 \)
Coconinoite \( \text{Fe}^{+++} \cdot 2\text{Al}_2(\text{UO}_2)_2(\text{PO}_4)_4(\text{SO}_4)_4(\text{OH})_2 \cdot 20\text{H}_2\text{O} \)
Dewindtite \( \text{Pb}_3(\text{UO}_2)_2(\text{PO}_4)_4(\text{OH})_4 \cdot 10\text{H}_2\text{O} (?) \)
Dumontite \( \text{Pb}_2(\text{UO}_2)_3(\text{PO}_4)_2(\text{OH})_4 \cdot 3\text{H}_2\text{O} \)
Fritzscheite \( \text{Mn}(\text{UO}_2)_2(\text{P}, \text{V})\text{O}_4 \cdot 8\text{H}_2\text{O} (?) \)

Grayite Thorium phosphate, perhaps \( (\text{Th}, \text{Pb}, \text{Ca})(\text{PO}_4) \cdot 8\text{H}_2\text{O} \)

Hydrogen autunite \( \text{H}_2(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 5 - 10\text{H}_2\text{O} \)
Kivuite \( (\text{Th}, \text{Ca}, \text{Pb})\text{H}_2(\text{UO}_2)_4(\text{PO}_4)_2(\text{OH})_8 \cdot 7\text{H}_2\text{O} \)
Lermontovite \( (\text{U}, \text{Ca}, \text{R.E}.\text{*})_2(\text{PO}_4)_4 \cdot 6\text{H}_2\text{O} \)
Meta-ankoleite \( \text{K}_3(\text{UO}_2)_4(\text{PO}_4)_2 \cdot 6\text{H}_2\text{O} \)
Meta-autunite I \( \text{Ca}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 2 - 6\text{H}_2\text{O} \)
Meta-autunite II \( \text{Ca}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 0 - 6\text{H}_2\text{O} \)
Metasaléite \( \text{Mg}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 4 (?) \text{H}_2\text{O} \)

Metatorbernite \( \text{Cu}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot \text{nH}_2\text{O}, \text{where } n = 4 (?) \text{ to 8.} \)

Meta-uranocirceite \( \text{Ba}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O} \)

Monazite \( (\text{Ce}, \text{La}, \text{Nd})\text{PO}_4\), with Th substituting for \( (\text{Ce}, \text{La}) \).

Natroautunite \( \text{Na}_2(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O} \)
Ningyoite \( (\text{U}, \text{Ca}, \text{R.E}.\text{*})_2(\text{PO}_4)_2 \cdot 1 - 2\text{H}_2\text{O} \)
Parsonsite \( \text{Pb}_2(\text{UO}_2)_2\text{PO}_4 \)
Phosphuranylite \( \text{Ca}(\text{UO}_2)_4(\text{PO}_4)_2(\text{OH})_4 \cdot 7\text{H}_2\text{O} \)

Prahevalskite \( \text{Pb}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 2\text{H}_2\text{O} \)

Pseudo-autunite \( (\text{H}_2\text{O})_2\text{Ca}(\text{UO}_2)(\text{PO}_4)_2 \cdot 2.5\text{H}_2\text{O} \)
Renardite \( \text{Pb}(\text{UO}_2)_4(\text{PO}_4)_2(\text{OH})_4 \cdot 7\text{H}_2\text{O} \)
Sabugalite \( \text{HAl}(\text{UO}_2)(\text{PO}_4)_2 \cdot 16\text{H}_2\text{O} \)
Saleéite \( \text{Mg}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 8 - 10\text{H}_2\text{O} \)

Saryarkite \( (\text{Ca}, \text{Y}, \text{Th})_2\text{Al}_2(\text{SiO}_4)(\text{PO}_4)_4(\text{OH})_9 \cdot 9\text{H}_2\text{O} \)

Sodium uranospinite \( (\text{Na}_2, \text{Ca})(\text{UO}_2)_2(\text{AsP})\text{O}_4 \cdot 5\text{H}_2\text{O} \)
Torbernite \( \text{Cu}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 12\text{H}_2\text{O} \)

Uranphite \( (\text{NH}_4)(\text{UO}_2)(\text{PO}_4) \cdot 3\text{H}_2\text{O} \)

Uranospathite \( \text{Cu}(\text{UO}_2)_2(\text{AsO}_4, \text{PO}_4)_2 \cdot 11\text{H}_2\text{O} (?) \)

See also. Unnamed minerals, p. 42-43.

Selenites:

Demessmaekerite \( \text{Pb}_2\text{Cu}_5(\text{UO}_2)_5(\text{SeO}_4)_8(\text{OH})_6 \cdot 2\text{H}_2\text{O} \)
Guilleminite \( \text{Ba}(\text{UO}_2)_3(\text{OH})_4(\text{SeO}_4)_2 \cdot 3\text{H}_2\text{O} \)

* Rare earths.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

Silicates:

Barium uranophane Contains major Ba, U, Si.
Beta-uranophane Ca(UO$_2$)$_2$(SiO$_2$)$_2$(OH)$_2$·5H$_2$O
Bilibinite 3(Ca, Pb)O·(U, Th)O$_2$·7UO$_2$·10SiO$_2$·19H$_2$O
Boltwoodite K$_2$(UO$_2$)$_2$(SiO$_2$)$_2$(OH)$_2$·5H$_2$O
Caryocerite Borosilicate of Ce, Y, and Th.
Cerphosphorhuttonite (Th, Ce)(Si, P)O$_4$·1.5H$_2$O
Cheralite (Ca, Th, Ce)(P, Si)O$_4$
Chevkinite (Ce, Y, Ca, U, Th)$_2$(Ti, Fe, Mg)$_2$(Si, Al)$_2$O$_4$(?)
Coffinite U(SiO$_4$)$_2$·(OH)$_4$
Cuprosklodowskite Cu(UO$_2$)$_2$(SiO$_2$)$_2$(OH)$_2$·5H$_2$O
Ekanite (Th, U)(Ca, Fe, Pb)$_2$Si$_2$O$_5$
Haiweeite CaO·2UO$_2$·6SiO$_2$·5H$_2$O
Huttonite ThSiO$_4$
Hydrocerite (La, Ce, Th)$_2$(Si, P)O$_7$·5H$_2$O
Kasolite Pb(UO$_2$)(SiO$_2$)(OH)$_2$
Metahaiweeite CaO·2UO$_2$·6SiO$_2$·nH$_2$O
Nenankevite (U$^+$, Y, Ce)U$^+$(Ca, Mg, Pb)(SiO$_4$)$_2$(OH)$_4$·nH$_2$O
Orlite 3PbO·3UO$_2$·4SiO$_2$·6H$_2$O
Orthochevkinite Dimorph of chevkinite.
Perrierite (Ce, Y, Ca, Th)$_2$(Ti, Fe, Mg)$_2$(Si, Al)$_2$O$_4$(?)
Ranquilite 3CaO·4UO$_2$·10SiO$_2$·24H$_2$O
Saryarkite (Ca, Y, Th)$_2$Al$_4$(Si$_2$O$_7$)PO$_4$(OH)$_2$·9H$_2$O
Sklodowskite Mg(UO$_2$)$_2$(SiO$_2$)$_2$(OH)$_2$·5H$_2$O
Soddyite (UO$_2$)$_2$(SiO$_2$)$_2$(OH)$_2$·5H$_2$O
Steenstrupine (Ce, La, Th, Ca, Na)$_2$(Mn, Fe)(SiO$_2$)$_2$(OH)$_2$·2H$_2$O
Thorite ThSiO$_4$
Thorogummite Th(SiO$_4$)$_2$·(OH)$_4$
Thorsteenstrupine (Ca, Th, Mn)$_2$Si$_2$(O, F)$_{12}$·5.7H$_2$O
Trinitite Borosilicate of Ce, Y, Th, Ca, and F.
Uranophane Ca(UO$_2$)$_2$(SiO$_2$)$_2$(OH)$_2$·5H$_2$O
Ursilite 2(Ca, Mg)O·2UO$_2$·5SiO$_2$·9·10H$_2$O
Usigite $R^+$UO$_2$(SiO$_2$)$_2$·nH$_2$O
Weeksite K(UO$_2$)$_2$(SiO$_2$)$_2$·4H$_2$O
Yttrialite (Y, Th)$_2$Si$_2$O$_7$
See also Unnamed minerals, p. 43.

Sulfates:

Calciouraconite Near Ca(UO$_2$)$_2$(SO$_4$)$_2$(OH)$_4$·20H$_2$O
Coconinoite Fe$_2$Al$_2$(UO$_2$)$_2$(PO$_4$)$_4$(SO$_4$)(OH)$_2$·20H$_2$O
Cuprozippeite Cu(UO$_2$)$_2$(SO$_4$)$_2$(OH)$_2$·11H$_2$O
Johannite Cu(UO$_2$)$_2$(SO$_4$)$_2$(OH)$_2$·6H$_2$O
Medjidite Supposedly a uranium sulfate.
Meta-uranopilite (UO$_2$)$_2$(SO$_4$)(OH)$_2$·5H$_2$O(?)
Schoeckingerite NaCa$_2$(UO$_2$)(CO$_3$)(SO$_4$)F·10H$_2$O
Uranochalceite Supposedly a uranium sulfate.
Uranopilite (UO$_2$)$_2$(SO$_4$)(OH)$_2$·12H$_2$O
Voglianite Hydrous calcium uranium sulfate.
Zippeite K$_4$(UO$_2$)$_2$(SO$_4$)$_2$(OH)$_2$·10H$_2$O

Tellurites:

Moctezumite PbO·UO$_2$·2TeO$_2$

† Meaning of $R$ not specified.
Vanadates:

Carnotite $K_2(UO_2)_2(VO_4)_2\cdot nH_2O (n=1 \text{ to } 3)$
Ferghanite $(UO_2)_3(VO_4)_2\cdot 6H_2O(?)$
Francevillite $(Ba, Pb)(UO_2)_2(VO_4)_2\cdot 5H_2O$
Fritzscheite $Mn(UO_2)_3[(P, V)O_4]_2\cdot 8H_2O(?)$
Metatyuyamunite $Ca(UO_2)_2(VO_4)_2\cdot 3\text{ to } 5H_2O$
Rauvite $CaO\cdot 2UO_2\cdot 5V_2O_5\cdot 16H_2O(?)$
Sengierite $Cu(UO_2)_2(VO_4)_2\cdot 8\text{ to } 10H_2O$
Tyuyamunite $Ca(UO_2)_2(VO_4)_2\cdot 5\text{ to } 8H_2O$
Uvanite $U_2V_4O_{21}\cdot 15H_2O(?)$
Vanuralite $(UO_2)_2Al(VO_4)_2(OH)\cdot 8H_2O$
Vanuranylite $[(H_2O)_{1.5}(Ba, Ca, K, Pb)_{0.4}](UO_2)_2(VO_4)_2\cdot 4.2H_2O$

See also Unnamed minerals, p. 43.
A. URANIUM AND THORIUM MINERALS

ABERNATHYITE
\[ \text{K}_2(\text{UO}_2)_2(\text{AsO}_4)_2 \cdot 6\text{H}_2\text{O} \]
Potassium member of the meta-autunite group.
\[ U = 45.8 \text{ percent.} \]
Am. Mineralogist, v. 41, p. 82–90 (1956).

AESCHYNITE (or eschynite)
\[(\text{Ce, Ca, Fe}^{2+}, \text{Th})(\text{Ti, Nb})_2(\text{O, OH})_6 \]
Part of the aeschynite-priorite series.
\[ \text{Th} = 9.9 \text{ to } 25.8 \text{ percent, } U = \text{up to 2.5 percent.} \]
Color: Black to brown. From granite pegmatites and nepheline syenites.

Alumo-aeschynite
Aluminian aeschynite.
\[ \text{Th} = 1.6 \text{ percent.} \]

Lyndochite
Variety of aeschynite, relatively high in Ca and Th and low in U.

See also Niobo-aeschynite, p. 56.

Thoro-aeschynite
A thorium-rich variety.
\[ \text{Th} = 25.8 \text{ percent, } U = 0.8 \text{ percent.} \]
From microcline veinlets in the contact zone of biotite syenites and gneisses.

ANDERSONITE
\[ \text{Na}_2\text{Ca}(\text{UO}_2)(\text{CO}_3)_2 \cdot 6\text{H}_2\text{O} \]
\[ U = 39.2 \text{ percent.} \]
Color: Bright green. Rare secondary mineral.
The American Journal of Science, v. 2, p. 239.

ARSENURANYLITE
\[ \text{Ca}(\text{UO}_2)_2(\text{AsO}_4)_2(\text{OH})_4 \cdot 6\text{H}_2\text{O} \]
Arsenic analog of phosphuranylite.
\[ U = 58.3 \text{ percent.} \]
URANIUM AND THORIUM MINERALS

AUTUNITE

\[ \text{Ca(UO}_2\text{)}_2(\text{PO}_4)_2\cdot 10-12\text{H}_2\text{O} \]

\( U = 48.3 \text{ to } 50.1 \text{ percent.} \)


Calciumphosphoruranite

Synonym of autunite.

Mineralog. Mag., v. 28, p. 732 (1949).

Calcouranite

Synonym of autunite.


Chalco-uranite

Synonym of autunite.


Lime-uranite

Synonym of autunite.


See also Meta-autunite, p. 24.

BARIUM URANOPHANE

Contains Ba, U, Si, with a little Mo, Al, and Ca.

Needs further study.


BASSETITE

\[ \text{Fe(UO}_2\text{)}_2(\text{PO}_4)_2\cdot 8\text{H}_2\text{O} \]

\( U = 51.0 \text{ percent.} \)

Color: Yellow. Rare secondary mineral.


Iron uranite

Incompletely examined mineral from New Mexico.

May be bassetite or altered bassetite.


BAYLEYITE

\[ \text{Mg}_2(\text{UO}_2\text{)}(\text{CO}_3)_3\cdot 18\text{H}_2\text{O} \]

\( U = 28.9 \text{ percent.} \)

Color: Yellow. Rare secondary mineral.


BECQUERELITE

\[ 7\text{UO}_2\cdot 11\text{H}_2\text{O} \]

Isostructural with billietite and both natural and synthetic CaO-6UO_2\cdot 11H_2O.

\( U = 75.7 \text{ percent.} \)

BECQUERELITE—Continued

BERGENITE
Ba(UO$_2$)$_4$(PO$_4$)$_3$(OH)$_4$·8H$_2$O.
Barium analog of phosphuranylite.
U = 58.8 percent.
Color: Yellow. Rare secondary mineral.

Barium-phosphuranylite
Synonym of bergenite.

BETAFITE
Essentially a uranium-rich pyrochlore.
$A_{2-x}B_2O_6(O, OH)_x$, with $A = Ca, Na, U, Ce, Y$; $B = Nb, Ta, Ti, Fe^{+3}$.
It probably forms a continuous series with pyrochlore; the name betafite
is arbitrarily assigned to members of the series with $U$ greater than
15 percent.
Color: Yellow, brown, black.
From granitic pegmatites, alkalic rocks, carbonatites.
U = 15–24.5 percent; Th = 1.0–1.1 percent.

Aluminobetafite
Perhaps an aluminum-rich variety of betafite (Al$_2$O$_3$ = 15.7 percent),
but needs further study.
U = 18.1 percent, Th = less than 1.4 percent.

Blomstrandite
Synonym of betafite.
U = 16.3 percent.

Mendeleyevite
A titanian betafite.
U = up to 20 percent.

Samiresite
Possibly a plumboan betafite, but perhaps an independent species.
U = up to 18.7 percent.

BETA-URANOPHANE
Ca(UO$_2$)$_2$(SiO$_2$)$_2$(OH)$_2$·5H$_2$O
Dimorphous with uranophane.
U = 55.6 percent.
URANIUM AND THORIUM MINERALS

BETA-URANOPHANE—Continued

Beta-uranotile

Synonym of beta-uranophane.

Randite

A mixture of beta-uranophane, some tyuyamunite, and calcite.

BILIBINITE

3(Ca,Pb)O·(U,Th)O₂·7UO₃·10SiO₂·19H₂O
Extreme uranium member in a series of amorphous thorium-uranium silicates of variable composition.
U=42.7 percent; Th=1.3 percent.
Color: Black. Occurs as cementing material in sandstones.

Compare Thorogummite, p. 39.

BILLIETITE

BaO·6UO₂·11H₂O or Ba₅U₅O₁₈(OH)₆·8H₂O
Isostructural with becquerelite and natural and synthetic CaO·6UO₂·11H₂O.
Barium analog of compreignacite.
U=68.8 percent.

BOLTWOODITE

K₂(UO₂)₂(SiO₄)₂(OH)₂·5H₂O
U=58.2 percent.
Color: Yellow. Secondary mineral in sandstone.

BRANNERITE

\(A₂B₄O₈\) with \(A = U\) mainly, also Ca, Fe, Th, Y; \(B = Ti\) mainly and Fe.
U=26.5 to 43.6 percent; Th=0.26 to 11.3 percent.
Color: Black, brown, yellowish brown. In granitic rocks, placers.
Dana VII, v. 1, p. 774-775.

Absite

2UO₂·ThO₂·7TiO₂·5H₂O
Thorian brannerite.
U=32.1 percent; Th=15.6 percent.
Color: Yellow, yellow brown, brownish olive green.
In granodiorite and quartz veins.

Cordobaite

Synonym of brannerite.

Lodochnikite

Synonym of brannerite.
Am. Mineralogist, v. 43, p. 380, 1007 (1958); v. 48, p. 1419-1420 (19639)

See also Thorutite, p. 40.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

BROCKITE

\((\text{Ca, Th})\text{PO}_4\cdot\text{H}_2\text{O}\)

\(\text{Th} = 36.8\) percent.

Color: Red and yellow. Occurs in veins in granitic rocks.

CALCIOSAMARSKITE

Probably \((\text{Ca, Y, Ce, U, Th})_3(\text{Nb, Ta, Fe, Ti, Sn})_6\text{O}_{19}(?)\)

\(\text{U} = 9.4\) to 11.3 percent; \(\text{Th} = 1.9\) to 2.9 percent.

Color: Black to brown. Rare, from granite pegmatite.
Dana VII, v. 1, p. 772.

CALCIOURACONITE

Near \(\text{Ca}(\text{UO}_2)_4(\text{SO}_4)_2(\text{OH})_6\cdot20\text{H}_2\text{O}\)

Validity questionable.
\(\text{U} = 53.7\) percent.
Boldyrev, A. K., Course of descriptive mineralogy, v. 3 (1935), Lenin­grad and Moscow.

CALCURMOLITE

\(\text{Ca}(\text{UO}_2)_2(\text{MoO}_4)_3(\text{OH})_2\cdot11\text{H}_2\text{O}\)

\(\text{U} = 39.4\) percent.


CARNOTITE

\(\text{K}_2(\text{UO}_2)_2(\text{VO}_4)_2\cdot3\text{H}_2\text{O}\)

\(\text{H}_2\text{O}\) can range from 1 to 3.

\(\text{U} = 52.8\) to 55.0 percent.


CARYOCERITE

A borosilicate of \(\text{Ce}, \text{Y}, \text{and Th chiefly}.

\(\text{U} = \text{trace}; \text{Th} = 12.0\) percent.

Color: Brown. From syenite pegmatite.
Dana VI, p. 415.

CERIANITE

\((\text{Ce, Th})\text{O}_2\)

\(\text{Ce}:\text{Th} = \text{about } 16:1\).

Isostructural with thorianite and uraninite.

\(\text{Th} = \text{about } 4.5\) percent.

CERPHOSPHORHUTTONITE

\((\text{Th, Ce})_2(\text{Si, P})_2\text{O}_7\cdot1.5\text{H}_2\text{O}, \text{with Si slightly greater than P.}\)

\(\text{Th} = 35.5\) percent; \(\text{U} = 1.4\) percent.

Color: Pale yellow to reddish brown. Occurs in amazonite pegmatite.
URANIUM AND THORIUM MINERALS

CHERALITE
Phosphate-silicate of Th, Ca, and rare earths.
Isostructural with monazite, conforming to monazite formula type
\[ AXO_4 \]
with \( A = \text{Th, Ca, Ce, La, U, Pb} \); \( X = \text{P, Si} \).
Is essentially an intermediate member of a solid solution series apparently extending between monazite, Ce\(\text{PO}_4\), and Ca\(\text{Th(PO}_4)_2\), known as an artificial compound.
U=3.5 to 5.5 percent; Th=25.9 to 27.7 percent.
Color: Green. Rare, from granite pegmatite.

CHEVKINITE (or tscheffkinite)
\[(\text{Ce, Y, Ca, U, Th})_2(\text{Ti, Fe, Mg})_2(\text{Si, Al})_2\text{O}_11(?), U=\text{up to 2.3 percent; Th=up to 18.4 percent.}
Color: Black. Accessory mineral in igneous rocks.

See also Perrierite, p. 31.

CLARKEITE
\[(\text{Na, Ca, Pb, Th, Ho})_2\text{U}_5(\text{O}_2\text{H}_3\text{O})_7, U=64.2 \text{ to 68.0 percent; Th=2.2 percent.}

COCONINOITE
\[\text{Fe}^{3+}\text{Al}_2\text{(UO}_2\text{)}_2(\text{PO}_4)(\text{SO}_4)(\text{OH})_2\cdot2\text{H}_2\text{O}, U=28.5 \text{ to 29.0 percent.}

COFFINITE
\[\text{U(SiO}_4\text{)}_{1-x}(\text{OH})_x, U=40.9 \text{ to 60.2 percent in concentrated, but not pure, samples.}
Color: Black very fine particles (-325 mesh), pale brown in transmitted light. Occurs in many deposits in sandstones and in hydrothermal veins.

See also Nenadkevite, p. 29.

COMPREIGNACITE
\[\text{K}_2\text{O}\cdot6\text{UO}_2\cdot11\text{H}_2\text{O}, \text{Potassium analog of billietite.}
U=71.0 percent.

COUSINITE
\[\text{MgO}\cdot2\text{MoO}_3\cdot2\text{UO}_2\cdot6\text{H}_2\text{O}, \text{Description of mineral inadequate. May possibly be moluranite.}
U=48.8 percent.
CUPROSKLODOWSKITE (or cuprosklowskite)
Cu(UO$_2$)$_2$(SiO$_2$)$_2$(OH)$_2$·5H$_2$O
Isostructural with sklodowskite and uranophane.
U=54.1 percent.

Jáchymovite
Synonym of cuprosklodowskite.
Mineralog. Abs., v. 6, p. 345 (1936).

Kieselkupfer-uranoxyd
Synonym of cuprosklodowskite.

C UPROZIPPEITE
Cu(UO$_2$)$_2$(SO$_4$)$_2$(OH)·11H$_2$O
Validity questionable.
Boldyrev, A. K., Course of descriptive mineralogy, v. 3, p. 83 (1935),
Leningrad and Moscow.

CURITE
3PbO·8UO$_2$·5H$_2$O
U=61.8 to 62.6 percent.
Color: Orange red. An alteration product of uraninite.

DAVIDITE
$A_6B_{15}$(O$_3$OH)$_{36}$, where $A$=Fe$^{+2}$, rare earths, U, Ca, Zr, Th; $B$=Ti, Fe$^{+3}$, V, Cr.
Ideal end member is FeTio$_7$.
U=up to 4.4 percent; Th=up to 0.12 percent.
Color: Black. A primary mineral in high-temperature hydrothermal lodes.
Econ. Geology, v. 54, p. 64–81 (1950).

Ferutite
Synonym of davidite.
U=12.5 percent; Th=0.06 percent.
Color: Black. A detrital mineral.

Mavudzite
Probably the same as ferutite.

Ufertite
Synonym of davidite.
U=2.3 percent; Th=0.14 to 0.18 percent.
Color: Brownish-black. Occurs in biotite gneisses and quartz-biotite schists.
DAVIDITE—Continued
Unnamed mineral from Tête district of Mozambique
Possibly $AB_3(O,OH)_n$, where $A=Fe^{+2}$, rare earths, $U^{+6}$, Ca, Na, Zr, Th; $B=Ti, Fe^{+3}, V, Cr$.
Probably davidite.
U=2.7 percent; Th=0.06 to 0.12 percent.

DEMESMAEKERITE
$Pb_2Cu_4(UO_2)_3(SeO_3)_4(OH)_4\cdot2H_2O$
U=22.5 percent.
Color: Bottle green to clear olive green. Occurs in lower part of oxidation zone.

DEWINDTITE
$Pb_2(UO_2)_5(PO_4)_3(OH)_4\cdot10H_2O$?
Isostructural with phosphuranylite and renardite; possibly identical with renardite.
U=49.5 percent.

Stasite
Synonym of dewindtite.

DROOGMANSITE
No chemical analysis has been made.
May be related to sklodowskite.
Am. Mineralogist, v. 11, p. 168 (1926).

DUMONTITE
$Pb_2(UO_2)_3(PO_4)_2(OH)_4\cdot3H_2O$
U=46.5 percent.

EKANITE
$(Th, U)(Ca, Fe, Pb)_3Si_3O_{10}$
U=1.8 percent; Th=24.0 percent.
Color: Green. Occurs in gem-bearing gravel, Ceylon.

ESCHYNITE. See Aeschynite, p. 10.

EUXENITE
$(Y, Ca, Ce, U, Th)(Nb, Ta, Ti)_2O_6$
Part of the euxenite-polycrase series.
U=0.6 to 12.45 percent; Th=up to 14.2 percent.
Color: Black. From granite pegmatites.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

EUXENITE—Continued

Delorenzite
originally described as \((Y, U, Fe)(Ti, Sn)_3O_8\), but recently shown to be
tanteuxenite.
\(U = 6.6\) percent.
Dana VII, v. 1, p. 808.

Eschwegeite
Tantalian variety of euxenite.

Oliveiraite
Alteration product of euxenite.

Tanteuxenite
Variety of euxenite with Ta substituting for Nb.

Titanoniobite
Allied to euxenite.

FENGHUANGLITE (or Feng-huang-shih)
An unnecessary name for thorium-rich britholite.
\((Ca, Ce, La, Th)_{34} (Si, P, C)O_{4a} (O, OH) (?)\)
Th = 17.3 percent.
Color: Yellowish brown. From nepheline hyroxenite.

Fynchenite
Russian transliteration of Feng-huang-shih.

FERGHANITE
Possibly \((UO_2)_3(VO_3)_{2}·6H_2O\)
Perhaps leached or weathered tyuyamunite. Poorly defined; needs
further study.
U = 62.2 percent.

FERGUSONITE
\((Y, Er, Ce, Fe) (Nb, Ta, Ti)O_4\)
Part of the fergusonite-formanite series.
U = 0.8 to 7.2 percent; Th = 0.7 to 6.0 percent.
Color: Black; alters to brown and yellow. From granite pegmatites.
Soc. Française Minéralogie et Cristallographie Bull., v. 81, p. 338 (1958)

Adelpholite
Synonym of fergusonite(?)
A poorly defined substance, possibly an altered mossite.
URANIUM AND THORIUM MINERALS

FERGUSONITE—Continued
Alpha-fergusonite
Tetragonal fergusonite.

Arrhenite
An altered fergusonite.
Dana VII, v. 1, p. 762.

Beta-fergusonite
Monoclinic fergusonite.

Bragite
Synonym of fergusonite.

Kochelite
Synonym of fergusonite.

Risörite
Synonym of fergusonite.

Rutherfordite (not the same as Rutherfordite)
An altered fergusonite.

Sipylite
Synonym of fergusonite.

Tyrite
Synonym of fergusonite.

FORMANITE
(Y, U, Th, Ca)(Ta, Nb, Ti)O_4
Part of the fergusonite-formanite series.
U = 1.1 percent; Th = 1.1 percent.
Color: Black. From placers.
Dana VII, v. 1, p. 758, 760, 762.


FORMARIERITE
PbO·4UO_2·5H_2O
U = 64.6–65.3 percent.

FRANCEVILLITE
(Ba, Pb)(UO_2)_2(VO_2)_2·5H_2O
Apparantly the barium analog of meta-tyuyumunite.
U = 45.8 percent.
Color: Yellow. A secondary mineral; occurs in sandstone.
FRITZSCHEITE
\[ Mn(UO_2)_2(P,V)O_4k·8H_2O(?) \]
No analysis available. May be the manganese analog of torbernite.
Color: Reddish brown to hyacinth red. A rare secondary mineral.

GRAYITE
A thorium phosphate, no analysis given, with structure like that of rhabdophane, perhaps \((Th,Pb,Ca)PO_4·H_2O\)
Color: Yellow, powdery. From pegmatite.

Compare Ningyoite, p. 29.

GUILLEMINITE
\[ Ba(UO_2)_3(OH)_{4}(SeO_3)_{2}·3H_2O \]
\( U = 53.8 \) percent.

Compare Ningyoite, p. 29.

GUMMITE
Generic term for minerals occurring as alteration product of uraninite and not otherwise identified.
Group includes silicates, phosphates, and oxides.

Elisite
Synonym of gummite.
\( U = 57.2 \) percent.

Pittinite
Synonym of gummite.

Yttrogummite
Yttrian variety of gummite.
An alteration product of yttrian uraninite.

See also Urgite, p. 46.

HAIWEEITE
\[ CaO·2UO_3·6SiO_2·5H_2O \]
State of hydration uncertain.
\( U = 52.8 \) percent.
Color: Pale yellow to greenish yellow. A secondary mineral.

Gastunite
Synonym of haiweeite.
URANIUM AND THORIUM MINERALS

HALLIMONDITE
\[ \text{Pb}_2(\text{UO}_2)(\text{AsO}_4)_2 \]
U = 28.1 percent.

HEINRICHITE
\[ \text{Ba}_2(\text{UO}_2)(\text{AsO}_4)_{1.10-12}\text{H}_2\text{O} \]
Formula assumed on basis of similarity of X-ray powder pattern to that of zeunerite.
U = 40.7 to 41.9 percent.
Color: Yellow to green. A secondary mineral.

Sandbergerite
Synonym of heinrichite.

HIELMITE (or bjelmite)
\[ \text{AB}_2\text{O}_4 \text{ or } \text{A}_2\text{B}_4\text{O}_{16}, \text{ where } \text{A} = \text{Y, Fe}^{2+}, \text{ U}^{4+}, \text{ Mn, Ca; B} = \text{Nb, Ta, Sn, W}. \]
U = 4.0 to 4.3 percent.
Color: Black. From pegmatite.

HÜGELITE
\[ \text{Pb}_2(\text{UO}_2)(\text{AsO}_4)(\text{OH})_4\cdot3\text{H}_2\text{O} \]
No analysis, formula by analogy to dumontite, with which it is isostructural.

HUTTONITE
\[ \text{ThSiO}_4 \]
Dimorph of thorite, isostructural with monazite and cheralite.
Th = 71.6 percent.
Color: Colorless to pale cream. Rare mineral from granitic pegmatites, alaskite granite, and placers.

See also Cerphosphorhuttonite, p. 14.

HYDROCERITE
\[ (\text{La,Ce,Th})_2(\text{Si,P})_2\text{O}_7\cdot5\text{H}_2\text{O} \]
Amorphous, gives a ceritelike X-ray pattern when heated, and is perhaps related to rhabdophane.
Th = 13.3 percent.
Color: Yellow to honey yellow. Occurs in alkaline pegmatite.

HYDROGEN AUTUNITE
\[ \text{H}_2(\text{UO}_2)(\text{PO}_4)_{2.8-10}\text{H}_2\text{O} \]
U = 51.7 to 54.3 percent.
Color: Pale yellow. Rare secondary mineral.
HYDRONASTURAN
\[ \text{UO}_2 \cdot k\text{UO}_2 \cdot n\text{H}_2\text{O} \]
\[ k = 2.3 \text{ to } 5.0; \ n = 3.9 \text{ to } 9.0 \text{ percent.} \]
Of doubtful validity, presumably an altered pitchblende.
\[ U = 10.5 \text{ to } 45.0 \text{ percent.} \]

IANTHINITE
\[ \text{UO}_2 \cdot 5\text{UO}_2 \cdot 10-11\text{H}_2\text{O} \]
This has been known also as “ianthinite français,” and is not to be confused with “ianthinite,” redescribed as wyartite.
\[ U = 75.6 \text{ percent.} \]
Color: Violet black. Rare secondary mineral.

IRIGINITE
\[ \text{UO}_2 \cdot 2\text{MoO}_4 \cdot 3\text{H}_2\text{O} \]
\[ \text{or} \ [\text{U} \cdot \text{MoO}_4 \cdot 2(\text{OH})_2 \cdot 2\text{H}_2\text{O} \]
\[ U = 38.7 \text{ percent.} \]

ISHIKAWAITE
\[(\text{U}, \text{Fe}, \text{Y}, \text{Ce})(\text{Nb}, \text{Ta})\text{O}_4 \]
\[ U = 19.3 \text{ percent.} \]
Color: Black. Rare, from granite pegmatites.
Dana VII, v. 1, p. 766.

JOHANNITE
\[ \text{Cu}(\text{UO}_2)_2(\text{SO}_4)_2(\text{OH})_2 \cdot 6\text{H}_2\text{O} \]
\[ U = 50.8 \text{ percent.} \]

Gilpinite
Synonym of johannite.

Peligrotite
\[ \text{CuO} \cdot 2\text{UO}_2 \cdot 2\text{SO}_4 \cdot 3\text{H}_2\text{O} \]
Probably the same as johannite.
\[ U = 45.1 \text{ percent.} \]

Uranvitril
Synonym of johannite.

KAHLERITE
\[ \text{Fe}(\text{UO}_2)_2(\text{AsO}_4)_2 \cdot n\text{H}_2\text{O} \]
Formula assumed from qualitative tests.
KAHLERITE—Continued
Arsenate analogue of bassetite. Needs further study.
U=46.8 percent (?).
Color: Yellow to yellow green. A rare secondary mineral.

KASOLITE
Pb(UO₂)(SiO₃)(OH)₂
U=40.5 percent.
Color: Yellow to brown. A secondary mineral.

Compare Orlite, p. 30.

KHLOPINITE (or chlopinite, or hlopinite)
(Y, U⁴⁺, Th₂)(Nb, Ta, Ti, Fe)₇O₂₉ (?)
May be related to euxenite-polycrase.
U=7.2 percent; Th=1.9 percent.
Color: Black. From pegmatites.
Dana VII, v. 1., p. 792.

KIVUITE
(Th, Ca, Pb)H₂(UO₂)₄(PO₄)₃(OH)₈·7H₂O
Stated to be the thorium analog of phosphuranylite. Needs further study.
U=52.3 percent; Th=7.3 percent.
Color: Yellow. Earthy. From pegmatites.

KOBEITE
Perhaps AB₂(O, OH)₆
A=Y, U; B=Ti mainly, Fe³⁺, Nb, Ta.
U=8.4 to 10.7 percent; Th=0.7 to 1.0 percent.
Color: Black. From a pegmatite.

LERMONTOVITE
(U, Ca, R.E.*)₄(PO₄)₄·6H₂O
Needs further study. Possibly identical with ningyoite.
U=44.3 percent.
Color: Grayish green. Occurs in zone of cementation of hydrothermal deposits.

LIEBIGITE
Caₐ(UO₂)(CO₃)₂·10H₂O
U=33.5 percent.
Color: Green, yellow green. Rare secondary mineral.

Flutherite
Synonym of liebigite.

* Rare earths.
LIEBIGITE—Continued
Kalk-uran-carbonat
Synonym of liebigite.

Uranothallite
Synonym of liebigite.

MACKELVEYITE (or mckelveyite)
$\text{Near } \text{Na}_2\text{Ba}_4\text{Ca(Y,}\text{U})_2(\text{CO}_3)_9\cdot5\text{H}_2\text{O}$
$U=3.9$ percent; $\text{Th}=0.09$ percent.
Color: Dark green or black; rarely apple green. A secondary mineral.

MASUYITE
$\text{UO}_2\cdot2\text{H}_2\text{O}$
Probably isostructural with vandendriesscheite. Analysis of authentic material yielded no lead.
$U=73.9$ percent.
Color: Yellow to orange yellow. Rare secondary mineral.

MEDJIDITE
Supposedly a uranium sulfate.
Validity of species is questionable.

META-ANKOLEITE
$\text{K}_2(\text{UO}_2)_2(\text{PO}_4)_2\cdot6\text{H}_2\text{O}$
$U=49.6$ to 50.6 percent.
Color: Yellow. A rare secondary mineral found in granitic pegmatite and in sandstone.

META-AUTUNITE I
$\text{Ca(UO}_2)_2(\text{PO}_4)_2\cdot2-6\text{H}_2\text{O}$
Apparently not formed directly in nature, but most field and museum specimens of autunite have been dehydrated to this phase.
$U=53$ to 59 percent.

See also Autunite, p. 11.

Metakalkuranite
Synonym of meta-autunite.
Centraibl. Mineralogie, 1901, p. 709.

META-AUTUNITE II
$\text{Ca(UO}_2)_2(\text{PO}_4)_2\cdot0-6\text{H}_2\text{O}$
Not found in nature. Meta-autunite I passes into this phase on heating to about $80^\circ\text{C}$.
$U=53.0$ to 61.8 percent.
Color: Yellow.
URANIUM AND THORIUM MINERALS

META-AUTUNITE II—Continued

See also Autunite p. 11; Meta-autunite I, above.

Para-autunite
Ca(UO₂)₂(PO₄)₂
Completely dehydrated autunite. Equals meta-autunite II.
U = 61.8 percent.
Strunz, Hugo, Mineralogische Tabellen, 4th ed., 1966, p. 313; Leipzig,

METAHAIWEEITE
CaO·2UO₃·6SiO₂·nH₂O, where n = less than 5.
No analysis, apparently a dehydration product of haiweeite.
A secondary mineral.

METAHEINRICHITE
Ba(UO₂)₂(AsO₄)₂·8H₂O
U = 43.3 percent.
Color: Yellow to green. A secondary mineral.

Arsenuranocircite
Synonym of metaheinrichite.

Metasandbergerite
Synonym of metaheinrichite.

METAKAHLERITE
Fe(UO₂)₃(AsO₄)₂·8H₂O (?)
No analysis made; microchemical tests showed Fe, As, U. X-ray powder
pattern and optics indicate it is a meta form.
U = 45.7 percent.

METAKIRCHHEIMERITE
Co(UO₂)₃(AsO₄)₂·8H₂O
Microchemical analysis shows presence of Co, U, and As.
X-ray powder pattern shows it is a meta form.
U = 46.6 percent.

METANOVACEKITE
Mg(UO₂)₂(AsO₄)₂·4H₂O
Partly dehydrated form of novacekite.
U = 52.1 percent.
Color: Yellow.
Strunz, Hugo, Mineralogischen Tabellen, 4th ed., 1966, p. 312; Leipzig,
METASALÉEITE
\[ \text{Mg}(\text{UO}_2)_2(\text{PO}_4)_2\cdot4\text{H}_2\text{O}(?) \]
U = 65.1 percent.

METATORBERNITE
\[ \text{Cu}(\text{UO}_2)_2(\text{PO}_4)_2\cdot n\text{H}_2\text{O} \]
where \( n = 4 (?) \) to 8.
U = 50.8 to 55.0 percent.
Color: Green. A common secondary mineral.

See also Torbernite, p. 41.

Metachalcolite
Synonym of metatorbernite.

Metakupferuranit
Synonym of metatorbernite.
Centralbl. Mineralogie, 1901, pl. 618.

METATYUYAMUNITE
\[ \text{Ca}(\text{UO}_2)(\text{VO}_4)_2\cdot 3-5\text{H}_2\text{O} \]
Lower hydrate of tyuyamunite.
U = 52.9 to 55.1 percent.

META-URANOCIRCITE
\[ \text{Ba}(\text{UO}_2)(\text{PO}_4)_2\cdot 8\text{H}_2\text{O} \]
Belongs to the meta-series of hydrates of the metatorbernite group and
was known originally as uranocircite.
U = 47.1 percent.

Uranocircite
Now recognized as meta-uranocircite.

Bariumphosphoruranit
Synonym of uranocircite.
Mineralog. Mag., v. 28, p. 732 (1949).

META-URANOPILITE
\[ (\text{UO}_2)_6(\text{SO}_4)(\text{OH})_{10}\cdot 5\text{H}_2\text{O}(?) \]
Recent work indicates validity of species is doubtful.
U = 72.3 percent (?).

See also Uranopilite, p. 45.
META-URANOPILITE—Continued
Beta-uranopilite
Synonym of meta-uranopilite.
Dana VII, v. 2, p. 582.

META-URANOSPINITE
\[ \text{Ca}(\text{UO}_2)_2(\text{AsO}_4)_2 \cdot 8\text{H}_2\text{O} \]
It is uncertain whether this lower hydrate occurs naturally.
U=46.4 percent.

See also Uranospinite, p. 46.

METAZELLERITE
\[ \text{Ca}(\text{UO}_2)(\text{CO}_3)_2 \cdot 3\text{H}_2\text{O} \]
U=49.2 percent.

METAZEUNERITE
\[ \text{Cu}(\text{UO}_2)_2(\text{AsO}_4)_2 \cdot 8\text{H}_2\text{O} \]
U=46.4 percent.
Color: Green. A common secondary mineral.

MICROLITE
\[ A_2B_2O_8(\text{O OH,F}), \text{ where } A=\text{Na, Ca, Fe}^{+2}, \text{ U}^{+4}, \text{ Sb}^{+3}, \text{ Pb}, \text{ Th, Zr, Ce, Y}; B=\text{Nb, Ta, Ti, Sn, Fe}^{+3} \]
In pyrochlore-microlite series, with Ta greater than Nb.
U=up to 10.4 percent; Th=0.2 percent.
Color: Pale yellow, amber to dark brown. In granitic pegmatites and
in pegmatites related alkaline igneous rocks.

Bismutomicrolite
Variety of microlite.

Calciotantalite
Possibly a mixture of microlite and tantalite.
Dana VII, v. 1, p. 787.

Djalmaite
Synonym of microlite.

Haddamite
Synonym of microlite.
Dana VII, v. 1, p. 748.

Metasimpsonite
An alteration product of simpsonite; later identified with microlite.
MICROLITE—Continued

Neotantalite
An altered microlite with composition close to tantalite.
Dana VII, v. 1, p. 748, 750–751, 753.

Niobtantalpyrochlore
Synonym of microlite.
Chemie der Erde, v. 7, p. 56 (1932).

Tantalpyrochlore
Synonym of microlite.
Chemie der Erde, v. 7, p. 56 (1932).

MOCTEZUMITE
\[ \text{PbO} \cdot \text{UO}_2 \cdot 2\text{TeO}_2 \]
\[ \text{U} = \text{24.2 percent.} \]

MOLURANITE
\[ \text{UO}_2 \cdot 3\text{UO}_2 \cdot 7\text{MoO}_3 \cdot 20\text{H}_2\text{O} \]
\[ \text{U} = \text{36 percent.} \]
Color: Black. Occurs in fissures in granulated albitite.

MONAZITE
\((\text{Ce}, \text{La}, \text{Nd})\text{PO}_4\)
with Th substituting for \((\text{Ce}, \text{La})\) and Si for P.
Th is normally from a few percent to 10.6 percent, but series probably extends to 26.4 percent. U is usually less than 0.1 percent.

Compare Cerphosphorhuttonite and cheralite, p. 14, 15.

Cryptolite
Synonym of monazite.
Dana VII, v. 2, p. 691.

Edwardsite
Synonym of monazite.
Dana VII, v. 2, p. 691.

Eremite
Synonym of monazite.
Dana VII, v. 2, p. 691.

Guadarramite
An intergrowth of radioactive monazite and some ilmenite.

Korarfveite
Impure monazite.
Dana VII, v. 2, p. 691.

Mengite
Synonym of monazite.
Dana VII, v. 2, p. 691.
URANIUM AND THORIUM MINERALS

MONAZITE—Continued

Monazitoid
Synonym of monazite.
Dana VII, v. 2, p. 691.

Phosphocerite
Synonym of monazite.
Dana VII, v. 2, p. 691.

Turnerite
Synonym of monazite.

Urdite
Synonym of monazite.
Dana VII, v. 2, p. 691.

MOURITE
Hydrous uranous uranic molybdate.
U = 18.5 percent.

NATROAUTUNITE (or sodium autunite, or soda-autunite)
\[ \text{Na}_2(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 8\text{H}_2\text{O} \]
A member of the meta-autunite group.
U = 46.7 percent.
Color: Yellow. From granodiorite massifs.
The geology of uranium, 1958, p. 66–69. Translated from Russian by Consultants Bur., Inc.

NENADKEVITE
\[ (\text{U}^{+4}, \text{Y}, \text{Ce}) \text{U}^{+6}(\text{Ca}, \text{Mg}, \text{Pb})(\text{SiO}_4)_2(\text{OH})_4 \cdot n\text{H}_2\text{O} \]
Much like coffinite, but perhaps distinct from it. Probably a high U-member in series thorite-uranotherite-nenadkevite (not to be confused with nenadkevichite).
U = 19.2 to 55.0 percent; Th = 0.009 to 0.3 percent.
Color: Black, greenish black, brown to reddish brown, orange and yellow. Occurs in zone of sodium metasomatism of iron-uranium deposits.
The geology of uranium, 1958, p. 43–55. Translated from Russian by Consultants Bur., Inc.

NINGYOITE
\[ (\text{U}^{+4}, \text{Ca}, \text{R.E.}^*)_2(\text{PO}_4)_2 \cdot 1–2\text{H}_2\text{O} \]
Has a structure similar to that of rhabdophane.
U = 20.4 percent.
Color: Brownish green to brown. Occurs as coatings or filling cavities in U ore.

*Rare earths.
NOHLITE
\[(\text{Ca, Mg, Fe}^{+2}, \text{Y, U})_2(\text{Nb, Zr, Fe}^{+3})_3\text{O}_10\]
Validity of species is doubtful.
\[\text{U}=13.0 \text{ percent.}\]
Color: Brownish black. From a feldspar quarry.

NOVACEKITE
\[\text{Mg(UO}_2\text{)}_2(\text{AsO}_4)_2-8-10\text{H}_2\text{O}\]
Arsenate end-member of saléeite-novacekite series.
\[\text{U}=51.6 \text{ to } 53.7 \text{ percent.}\]

Novacekite I and II
Various hydrates of novacekite.

OBRUCEVITE
\[(\text{Y, Na, Ca, U})(\text{Nb, Ta, Ti, Fe})_2(\text{O, OH})_7\text{H}_2\text{O}\]
A member of the pyrochlore group with Y predominant.
\[\text{U}=8.1 \text{ to } 10.9 \text{ percent}; \text{Th}=0.1 \text{ to } 0.2 \text{ percent.}\]
Color: Brown to chocolate brown. From granitic pegmatites.

Yttrobetafite
A uranoan variety of obruchevite.
\[\text{U}=10.9 \text{ percent}; \text{Th}=1.1 \text{ percent.}\]
Color: Greenish black.

ORLITE
\[3\text{PbO}·3\text{UO}_2·4\text{SiO}_2·6\text{H}_2\text{O}\]
Close to kasolite. Needs further study.
\[\text{U}=38.1 \text{ percent.}\]
Color: Light cream to yellow. A secondary mineral.

ORTHOCHEVKINITE
Complex alumino-silicate of Ti, Fe, Mg, Ca, Th, Ce, and rare earths.
Polymorph of chevkinite.

PARAPITCHBLENDE
Oxide of uranium, chiefly \[\text{U}^{+4}\], minor \[\text{U}^{+4}\].
Name given provisionally to material requiring further study. Probably a gummite-type alteration product of uraninite.

PARSONSITE
\[\text{Pb}_2(\text{UO}_2)(\text{PO}_4)_2\]
\[\text{U}=24.7 \text{ to } 28.8 \text{ percent.}\]
URANIUM AND THORIUM MINERALS

PAULITE
Perhaps the arsenate analog of sabugalite.
\[ \text{HAl(UO}_2\text{)}_4(\text{AsO}_4)_4\cdot16\text{H}_2\text{O} \text{ (No analysis.)} \]
Color: Light yellow. A secondary mineral.

PERRIERITE
\[(\text{C}_\text{e},\text{Ca},\text{Y},\text{Th})_2(\text{Ti,Fe,Mg})_2(\text{Si,Al})_2\text{O}_11(?)\]
Perhaps a polymorph of chevkinite.
Th = 3.6 percent.

PHOSPHURANYLITE
\[\text{Ca(UO}_2\text{)}_4(\text{P0}_4)_2\cdot(\text{OH})_4\cdot7\text{H}_2\text{O}\]
Isostructural with renardite and dewindtite.
U = 63.3 percent.

PISEKITE
An ill-defined mineral, essentially a niobate-tantalate-titanate of U and rare earths, with Th and Sn. May be related to amgangabeite.
Color: Yellowish brown to black. From granite pegmatite.
Narodni Mus., Prague, Casopis Mineralogie Geologie, v. 1, p. 2 (1923).

POLYCRASE
\[(\text{Y,Ca,Ce,U,\text{Th}})_2(\text{Ti,Nb,Ta})_2\text{O}_6\]
Part of the euxenite-polycrase series.
U = 5.5 to 12.4 percent; Th = up to 4.7 percent.
Color: Black. From granite pegmatites.

PRIORITE
\[(\text{Y,Er,Ca,Fe}^{+2},\text{Th})_2(\text{Ti,Nb})_2\text{O}_6\]
Part of the aeschynite-priorite series.
U = 0.4 to 3.4 percent; Th = 0.5 to 14.9 percent.
Color: Black. From granite pegmatites and nepheline syenites.

Blomstrandine (or blomstrandinite)
Synonym of priorite.

PRZHEVALSKITE (or prjevalskite)
\[\text{Pb(UO}_2\text{)}_2(\text{PO}_4)_2\cdot2\text{H}_2\text{O}\]
U = 48.9 percent.

PSEUDO-AUTUNITE
\[(\text{H}_2\text{O})_2\text{Ca(UO}_2\text{)}_2(\text{PO}_4)_2\cdot2.5\text{H}_2\text{O}\]
Chemical and X-ray results indicate that the mineral is not a member of the autunite or meta-autunite group.
U = 44.2 percent.
Color: Pale yellow to white. A secondary mineral.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

PYROCHLORE

$A_2B_2O_6(O,OH,F)$, where $A$ = Na, Ca mainly, also Fe$^{+2}$, U$^{+4}$, Sb$^{+3}$, Pb, Th, Ce, Y; $B$ = Nb, Ta, Ti mainly, also Sn, Fe$^{+3}$, W.

In pyrochlore-microlite series, with Nb greater than Ta.

$U = $ up to 1.4 percent, usually, but as much as 17.1 percent in some varieties; $Th = $ up to 5.5 percent.

Color: Pale yellow, amber to dark brown. In pegmatites derived from alkaline igneous rocks.

Dana VII, v. 1, p. 748-754.


See also Betafite, p. 12; microlite, p. 27; obruchevite, p. 30; pandaite, p. 56; and wiikite, p. 48.

Azor-pyrrhit

Synonym of pyrochlore.


Chalcolamprite

Synonym of pyrochlore.

Dana VII, v. 1, p. 748, 750, 754.

Ellsworthite

An altered uranoan variety of pyrochlore related to hatchettolite.


Endeiolite

Similar in composition to chalcolamprite.

An altered pyrochlore(?).

Dana VII, v. 1, p. 748, 754.

Fluochlore

Synonym of pyrochlore(?).


Hatchettolite

Uranoan variety of pyrochlore.

Dana VII, v. 1, p. 748, 750-752, 754.

Hydrochlore

Synonym of pyrochlore.


Koppite

Synonym of pyrochlore.

Dana VII, v. 1, p. 748, 754.

Marignacite

Synonym of pyrochlore.


Niobpyrochlore

Synonym of pyrochlore.

Chemie der Erde, v. 7, p. 56 (1932).

Priazovite

Probably a variety of pyrochlore.

PYROCHLORE—Continued

Pyrrhite
Synonym of pyrochlore.
Dana VII, v. 1, p. 748, 752, 754.

Uranopyrochlore
Synonym of pyrochlore.

RABBITTITE
Ca₃Mg₃(UO₂)₂₃(CO₃)₄(OH)$_4$·18H₂O
U = 31.1 percent.

RANQUILITE
3CaO·4UO₂·10SiO₂·24H₂O(?)
Doubtful, needs further study.
U = 39.7 percent.
Occurs in fissures in gypsum

RAUVITE
CaO·2UO₂·5V₂O₇·16H₂O(?)
U = 26.1 percent.

RENARDITE
Pb(UO₂)₄(PO₄)₂(OH)$_4$·7H₂O
Isostructural with phosphuranylite and dewindtite.
U = 57.3 percent.

RICHTITE
Contains Pb and U.

RUTHERFORDINE
(UO₂)CO₃
U = 72.1 percent.

Diderichite
Synonym of rutherfordine.
Glossary of Uranium- and Thorium-Bearing Minerals

SABUGALITE

\[ \text{HAL(UO}_2\text{)}_4(\text{PO}_4)_4 \cdot 16\text{H}_2\text{O} \]

\( U = 53.6 \text{ percent.} \)


SALÉEITE

\[ \text{Mg(UO}_2\text{)}_3(\text{PO}_4)_2 \cdot 8–10\text{H}_2\text{O} \]

Phosphate end-member of the saléeite-novacekite series.

\( U = 50.9 \text{ to } 53.0 \text{ percent.} \)


Magnesium-phosphoruranit

Synonym of saléeite.

Mineralog. Mag., v. 28, p. 732 (1949).

SAMARSKITE

\[ (\text{Y},\text{Ce},\text{U},\text{Ca},\text{Fe},\text{Pb},\text{Th})(\text{Nb},\text{Te},\text{Ti},\text{Sn})_2\text{O}_5 \]

\( U = 8.4 \text{ to } 16.6 \text{ percent; Th=} \text{up to } 3.7 \text{ percent.} \)

Color: Velvet black to brown. From granite pegmatites.

Dana VII, v. 1, p. 797–800.


Ampangabeite

Synonym of samarskite.


Annerôdite

Samarskite with parallel overgrowths of columbite.

Dana VII, v. 1, p. 797, 799.

Eytlandite

Synonym of samarskite.

Dana VII, v. 1, p. 797.

Hydrouxeuxenite (or ampangabeite)

Dana VII, v. 1, p. 806.

Hydrosamarskite

An altered samarskite.

Dana VII, v. 1, p. 799–800.

Nuevite

Synonym of samarskite.


Plumboniobite

A niobate of Y, U, Pb, Fe, and rare earths.

May be a plumbian variety of samarskite.

Dana VII, v. 1, p. 800.

Rogersite

Probably an altered samarskite.

Of doubtful validity.

Dana VII, v. 1, p. 800.
URANIUM AND THORIUM MINERALS

SAMARSKITE—Continued

Toddite
A mixture of samarskite and columbite.

Uranotantalite
Synonym of samarskite.
Dana VII, v. 1, p. 797.

Vietinghoffite
Supposedly a ferroan samarskite.
Dana VII, v. 1, p. 800-801.

Yttrio-ilmenite
Synonym of samarskite.
Dana VII, v. 1, p. 797.

SARYARKITE
(Ca, Y, Th)2Al4(SiO4, PO4)4(OH)·9H2O
Apparently a member of the rhabdophane group.
Th= 6.8 to 8.0 percent.
Color: White. Occurs in propylitized acid effusives and in altered granitic rocks.

SCHOEPITE (or schoepite I)
UO2·2H2O
U= 71.9 percent.
Dana VII, v. 1, p. 627-628.
Soc. Française Minéralogie et Cristallographie Bull., v. 82, p. 242-244 (1959).

Epiianthinite
Yellow pseudomorphous alteration of ianthinite; identical with schoepite.

Metaschoepite (or schoepite II)
Closely related to schoepite; contains less H2O.

Paraschoepite (or schoepite III)
Closely related to schoepite; contains less H2O.

SCHROECKINGERITE
NaCa8(UO2)(CO3)3(SO4)F·10H2O
U= 26.8 percent.

Dakeite
Synonym of Schroekingerite.
SCHROECKINGERITE—Continued

Neogastunite
Synonym of schroeckingerite.

SEDOVITE
U(MoO₄)₂(?)
U=36 percent.
Color: Brown to reddish brown. A secondary mineral from the oxidation zone.

SEDOVITE
U(MoO₄)₂(?)
U=36 percent.
Color: Brown to reddish brown. A secondary mineral from the oxidation zone.

SENGIERITE
Cu(UO₂)(VO₄)₂·8-10H₂O
U=47.0 to 48.7 percent.

SHARPITE
Perhaps (UO₂)(CO₃)·H₂O or 6UO₂·5CO₂·7H₂O
Composition needs to be checked.
U=68.4 to 68.6 percent.

SINICITE
Perhaps AB₂(O,OH)₅, where A=Ce, Y, U, Th; B=Ti, Nb mainly.
U=5.0 to 5.7 percent; Th=7.0 to 7.3 percent.
Needs further study; may be a variety of aeschynite.
Color: Blackish brown to reddish brown. Occurs in granite pegmatite.

SKLODOWSKITE (or sklodovskite)
Mg(UO₂)₂(SiO₄)₂(OH)₂·5H₂O
Isostructural with uranophane and cuprosklodowskite.
U=56.6 percent.

Chinkolobwite (or shinkolobwite)
Synonym of sklodowskite.
Mineralog. Abs., v. 3, p. 115 (1926).

SODDYITE (or soddite)
(UO₂)₅(SiO₄)₂(OH)₂·5H₂O
U=71.8 percent.

SODIUM URANOSPINITE
(Na₂,Ca)(UO₂)₄[(As,P)O₄]·5H₂O
A member of the meta-autunite group.
U=48.5 percent.
Color: Yellow green to lemon and straw yellow.
A secondary mineral in a primary hydrothermal deposit.
URANIUM AND THORIUM MINERALS

SODIUM URANOSPINITE—Continued

Ellweilerite
Probably a Ca-free variety of sodium uranospinite.

STEENSTRUPINE

(Ca,La,Th,Ca,Na)2(Mn,Fe)(SiO3)(OH)2·2H2O
Th = 1.9 to 9.96 percent; U = up to 0.18 percent.
Color: Brown to black. From syenite and alkalic rock pegmatites.
Dana VI, p. 415.

Manganosteenstrupine
A variety of steenstrupine with high Mn content.

STUDTITE
Hydrated carbonate of U and Pb.
Species not well defined.

SWARTZITE

CaMg(UO2)(CO3)3·12H2O
U = 32.6 percent.

THORBASTNAESITE

Th(Ce,Ca)(CO3)2F2·3H2O
Th = 41.0 percent; U = 0.09 percent.
Color: Brown. Accessory mineral in iron-rich albitites; selvages of veinlets and stockworks.

THORIANITE
Includes alpha-, beta-, and gamma-thorianite.
(Th,U)O2
Forms complete series with uraninite.
Division between thorianite and uraninite at Th:U = 1:1 atomic ratio
U = up to 44.6 percent; Th = 43.4 to 87.9 percent.
Color: Gray, black, brownish black. From placers.

Aldanite
A uranoan plumboan thorianite.
U = 12.4 to 16.7 percent, Th = 56.5 to 60.9 percent.
Soviet Geol., 1941, no. 6, p. 105–107.

Uranothorianite
Synonym for thorianite containing U.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

THORITE

\[ \text{ThSiO}_4 \]

- \( U = \text{up to 10.1 percent; Th} = 25.2 \text{ to 64.1 percent.} \)
- Color: Yellow, brown, black. From nepheline syenites and granites.
- Dana VI, p. 480-490.

See also Varieties listed under thorogummite, p. 39; hydrocerite, p. 21.

Auerlite

Phosphatian variety of thorite or thorogummite with \( \frac{(PO_4):(SiO_4)}{=0.8:1} \).

Calciotothorite

May be calcian variety of thorite or thorogummite.

Enalite

Uranoan variety of thorite or thorogummite.
- Am. Mineralogist, v. 18, p. 223 (1933); v. 38, p. 1007-1018 (1953).

Euurasite

Possibly a variety of thorite or thorogummite high in rare earths.

Ferrothorite

An altered variety of thorite; high in Fe.

Freyalite

Variety of thorite high in rare earths.

Jiningite

A variety of thorite high in \( Fe_2O_3 \) (17.28 percent), \( P_2O_5 \) (6.08 percent) and \( V_2O_5 \) (0.97 percent).
- \( Th = 39.4 \text{ percent; } U = 0.39 \text{ percent.} \)

Mozambikite

Possibly a variety of thorite or thorogummite.
- \( Th = 51.7 \text{ percent; } U = 5.1 \text{ percent.} \)

Orangite

Synonym of thorite.
- Dana VI, p. 488-489.

Shentulite (or shen-t'u-shih)

A variety of thorite; high in \( P_2O_5 \) (5.16 percent) and \( As_2O_5 \) (3.62 percent).
- \( Th = 46.4 \text{ percent.} \)
URANIUM AND THORIUM MINERALS

THORITE—Continued

Silicosmirnovskite
Similar to smirnovksite, but with Si>P.
Th = 39.8 percent.
Probably thorite or thorogummite.

Smirnovskite
Abbreviated theoretical formula: \((\text{Th,Ca,Ce})(\text{P,Al})(\text{OH})(\text{O,OH,F})_4\)
Probably a phosphate-rich metamict thorite, near auerlite.
U = 0.08 percent; Th = 45.0 to 46.7 percent.
Color: Reddish brown to dirty brown; also orange, yellow, or colorless.
Occurs in cassiterite-feldspar-quartz veins.

Uranotherite
Uranoan variety of thorite.

Wisaksonite
Uranoan variety of thorite.

Yanshainshynite
Probably a phosphatian thorite.
Th = 37.7 percent.

THOROGUMMITE
\(\text{Th}(\text{SiO}_4)_{1-x}(\text{OH})_{4x}\)
Isostructural with thorite.
U = 2.5 to 31.4 percent; Th = 18.2 to 50.8 percent.

See also Varieties listed under thorite, p. 38-39.

Compare Coffinite, p. 15.

Chlorothorite
Synonym of thorogummite.

Hyblite
Includes alpha- and beta-hyblite.
Synonym of thorogummite.

Hydrothorite
Synonym of thorogummite.

Hydroxyl-thorite
Synonym of thorogummite.

Mackintoshite
Synonym of thorogummite.
THOROGUMMITE—Continued
Maitlandite
\[2(\text{Pb},\text{Ca})O \cdot 3\text{ThO}_2 \cdot 8\text{SiO}_2 \cdot 23\text{H}_2\text{O}\]
Synonym of thorogummite.
U = 31.3 percent; Th = 21.7 to 22.7 percent.

Nicolayite
\[2(\text{Pb},\text{Ca})O \cdot 3\text{ThO}_2 \cdot 4\text{UO}_2 \cdot 8\text{SiO}_2 \cdot 21\text{H}_2\text{O}\]
Synonym of thorogummite.
U = 31.1 percent; Th = 21.5 percent.

Pilbarite
A mixture of thorogummite and kasolite.

THOROSTEENSTRUPINE
\[(\text{Ca},\text{Th},\text{Mn})_6\text{Si}_4(\text{O,F})_{12} \cdot 5-7\text{H}_2\text{O}\]
Th = 31.2 percent.
Color: Dark brown, nearly black. Occurs in metasomatic veins.

THORUTITE (or torutite)
\[(\text{Th},\text{Ca},\text{U})\text{Ti}_2(\text{O,OH})_6\]
Thorium analog of brannerite.
U = 2.2 percent; Th = 47.5 percent.
Color: Black. Occurs in syenite massif.

Smirnovite
Synonym of thorutite.

THUCHOLITE
A complex of uraninite with hydrocarbons.
U = up to 53 percent in the ash. Th = up to 48 percent in the ash.
Color: Black. Mainly from pegmatite dikes.
Am. Mineralogist, v. 38, p. 802 (1953)

Anthraxolite
A nickeliferous and uraniferous hydrocarbon.
U = 0.003 percent.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 121.

Asphaltite (or asphaltum)
Includes solid bituminous hydrocarbons known as albertite, impsonite, gilsonite, grahamite, and uintahite.
U = 0.001 percent.
Mineralog. Mag., v. 15, p. 417 (1910).
URANIUM AND THORIUM MINERALS

THUCHOLITE—Continued

Broggite
A variety of asphaltite.

Carbocer
A material similar to thucholite, high in Ce.

Carburan
A hydrocarbon complex related to thucholite.
U=4.3 percent.
Mineralog. Abs., v. 6, p. 437 (1936).

Grahamite
A uraniferous hydrocarbon like thucholite.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 121.

Sogrenite
An organo-uranium complex like thucholite.
U=9.8 to 16.6 percent, from microchemical analysis of inorganic part.
Color: Black. In ankerite-calcite veins cutting Upper Precambrian limestone.

Titanothucholite
Titanian variety of thucholite.
Mineralog. Abs., v. 9, p. 37 (1944).

TORBERNITE

Cu(UO₂)₂(PO₄)₂·12H₂O
U=47.1 percent.
Color: Green. A common secondary mineral.

See also Metatorbernite, p. 26.

Chalcolite (or chalkolith)
Synonym of torbernite.

Copper uranite
Synonym of torbernite.

Cuprouranit
Synonym of torbernite.

Kupferphosphoruranit
Synonym of torbernite.
Mineralog. Mag., v. 28, p. 732 (1949).

Torberite
Synonym of torbernite.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

TORBERNITE—Continued

Uranite
Synonym of torbernite-autunite group.

Uran-mica
Synonym of torbernite.
Jameson, Robert, System of Mineralogy (1820).

Uranophyllit
Synonym of torbernite.

TRITOMITE
A borosilicate of Ce, Y, Th, Ca, and F; exact formula uncertain.
Th=7.5 to 8.3 percent.
Color: Dark brown. From nepheline syenite pegmatite.
Dana VI, p. 416.

TROEGERITE
Probably H₂(UO₂)₂(AsO₄)₂·8H₂O
New analysis is needed.
U = 55.1 percent.

TSCHEFFKINITE. See Chevkinite, p. 15.

TYUYAMUNITE
Ca(UO₂)₂(VO₄)₂·5–8H₂O
U = 49.4 to 54.1 percent.

See also Metatyuyamunite, p. 26.
Calcioeckonitite
Synonym of tyuyamunite.

UMOHOITE
Close to (UO₂)(MoO₄)·4H₂O(?)
U = 47.4 percent.

UNNAMED MINERALS
(Antipov, 1900)
Essentially Cu(UO₂)(CO₄)₂·10H₂O
U = 37.6 percent.

(Belova and others, 1963)
(UO₂)₃(PO₄)₂·8H₂O
Phosphate analog of troegerite.
UNNAMED MINERALS—Continued

(Chernik, 1922)
Ill-defined vanadate of Cu and U.
Has same qualitative chemical composition as sengierite.
U=32.5 percent.

(Chirvinsky, 1925)
An incompletely described mineral presumed to contain U by virtue
of its properties and association. May be a variety of meta-
tyuyamunite.
Mineralog. Mag., v. 20, p. 287 (1925).

(Fronde!, 1956)
Mineral A
An oxide of U, or a uranate, containing Pb, K, Na, Ca, and Ba.
Color: Orange yellow or golden yellow. From pegmatites.

Mineral B
Possibly the calcium analog of kasolite.
Color: Straw yellow to pale yellowish brown. From pegmatites.

(Melkov, 1946)
Contains Bi, U, PO₄, and H₂O. Na, K in traces.
May be the phosphate analog of walpurgite.

(Protas, 1957)
CaO·6UO₃·11H₂O
Calcium analog of becquerelite.
U=74.2 percent.
Soc. Française Minéralogie et Cristallographie Bull., v. 82, p. 246–249
(1959).

(Protas, 1959)
Contains U, Sr, Ca, H₂O.
U=69.8 percent.
Soc. Française Minéralogie et Cristallographie Bull. v. 82, p. 250–252
(1959).
Dehydration of the above mineral gives a product with an X-ray powder
pattern identical to that of a pale mineral found in very small
amounts with the above.

(Soboleva and Pudovkina, 1957)
(Cu,Ca)(UO₂)₅[(P,As)₆·18H₂O(?)
Uranium mica of mixed composition. Needs further study.
U=35.5 to 40.0 percent.
Color: Green to yellow. A secondary mineral.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

UNNAMED MINERALS—Continued
(Walenta, 1958)

Mineral D, Mineral E
Contains U and As.
Color: Citron yellow. Secondary minerals.

URAONITE
This name has been used for uranium sulfates, but lacks specific meaning and should be abandoned.

URAMPHITE
(NH₄)(UO₂)(PO₄)·3H₂O
Possibly a member of the meta-autunite or meta-torbernite groups.
U=54.5 percent.
Color: Bottle green to pale green. Occurs in oxidized zone of a uranium-coal deposit.
The geology of uranium, 1958, p. 56-60, translated from Russian by Consultants Bur., Inc.

URANINITE
Ideally UO₂, but better expressed as (U⁴⁺₁₋ₓ, U⁺ₓ)O₂⁺ₓ.
Usually somewhat oxidized and varying in composition to at least (U⁴⁺,U⁺)O₂⁺.
Also contains Th, Pb, Y, and other rare earths in solid solution. Forms complete series with thorianite. Division between uraninite and thorianite at U:Th=1:1.
U=46.5 to 88.2 percent; Th=zero to 45.3 percent.
Color: Velvety brownish, grayish, and greenish black. In granite and syenite pegmatites (crystals); in hydrothermal sulfide veins (pitchblende); in sandstone-type deposits.

See also Hydronasturan, p. 22; parapitchblende, p. 30.

Bröggerite
A thorian variety of uraninite.

Cleveite
A variety of uraninite containing rare earths.

Coracite
Synonym of uraninite.
Dana VII, v. 1, p. 611, 615, 617.

Nasturan
Synonym of pitchblende.
URANINITE—Continued

Nivenite
A variety of uraninite containing rare earths.

Pitchblende
A colloform, fine-grained variety of uraninite.

Ulrichite
Synonym of uraninite.
Dana VII, v. 1, p. 611, 613, 617.

Uranatemnite
Synonym of uraninite.

Uranoniobite
Synonym of uraninite.
Dana VII, v. 1, p. 611, 613.

Uranopissite
Synonym of uraninite.
Mineralog. Mag., v. 16, p. 374 (1913).

URANOCHALCITE
An ill-defined uranium sulfate of doubtful validity.

URANOCHER
A generic term used chiefly for uranium sulfates; also used for some uranium oxides.

URANOPHANE
\[ \text{Ca(UO}_2\text{)}_3(\text{SiO}_3)_2(\text{OH})_2\cdot5\text{H}_2\text{O} \]
Dimorphous with beta-uranophane; isostructural with sklodowskite and cuprosklodowskite.
U = 55.6 percent.

Lambertite
Synonym of uranophane.

Uranotil (or uranotile)
Synonym of uranophane.
Dana VI, p. 699.

URANOPILITE
\[ (\text{UO}_2)\text{_6(SO}_4\text{)}\text_(0H)_10\cdot12\text{H}_2\text{O} \]
U = 67.9 percent.

See also Meta-uranopilite, p. 26.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

URANOSPATHITE
\[ \text{Cu(UO}_2\text{)}_2(\text{AsO}_4\text{PO}_4)_2\cdot11\text{H}_2\text{O} (?) \]
U = 46.0 percent (?).  
Color: Yellow to pale green. A rare secondary mineral.  

URANOSPHAERITE (or uranospherite)
\[ \text{BiUO}_4(\text{OH}) \]
U = 45.1 percent.  
Color: Orange to red. A rare secondary mineral.  

URANOSPINITE
\[ \text{Ca(UO}_2\text{)}_3(\text{AsO}_4)_2\cdot10\text{H}_2\text{O} \]
U = 45.9 percent.  
Color: Yellow to green. A rare secondary mineral.  

Calciumarsenuranit  
Synonym of uranospinite.  
Mineralog. Mag., v. 28, p. 732 (1949).

URGITE (or urhite, or urhyte)
\[ \text{UO}_2\cdot\text{nH}_2\text{O} \]
Possibly a mixture equivalent to “gummite.”  
U = 58.9 to 59.2 percent.  

URSILITE
\[ 2(\text{Ca, Mg})\text{O} \cdot 2\text{UO}_2 \cdot 5\text{SiO}_2 \cdot 9–10\text{H}_2\text{O} \]
Calcium ursilite, with Ca predominant; magnesium ursilite, with Mg predominant.  
U = 41.4 to 42.1 percent. Inadequately described.  
Color: Lemon yellow. Occurs along joints in quartz porphyries.  
The geology of uranium, 1958, p. 61–65, translated from Russian by Consultants Bur., Inc.  

USIGITE (or usihite, or usihyte)
\[ \text{R}\dagger(\text{UO}_2\text{)}_2\text{Si}_2\text{O}_7\cdot\text{nH}_2\text{O} \]
Inadequately described mineral.  
Color: Yellow.  

UVANITE
\[ \text{U}_2\text{V}_6\text{O}_{21}\cdot15\text{H}_2\text{O} (?) \]
U = 34.3 percent (?).  

\dagger\text{Meaning of R not specified.}
URANIUM AND THORIUM MINERALS

VANDENBRANDEITE
CuUO₄·2H₂O
U = 59.3 percent.

Uranolepidite
Synonym of vandenbrandeite.

VANDENDRIESSCHEITE (or vandendriesscheite I)
PbO·7UO₃·12H₂O(?)
U = 68.3 percent.
Am. Mineralogist, v. 18, p. 20–24 (1933).

Metavandendriesscheite (or vandendriesscheite II)
A phase related to vandendriesscheite and perhaps a lower hydrate.

VANURALITE
(UO₂)₂Al(VO₄)₂(OH)·8H₂O
U = 50.0 percent.

VANURANYLITE
[(H₂O)₁·₂(Ba,Ca,K,Pb)₀·₄](UO₂)₂(VO₄)₂·4·₂H₂O
An oxonium member of the carnottite group.
U = 48.5 percent.

VOGLIANITE
A hydrous calcium and uranium sulfate of doubtful validity.

VOGLITE
Ca₂Cu(UO₂)(CO₃)₄·6H₂O
U = 31.3 percent.

Uran-Kalk-Kupfer-Carbonat
Synonym of voglite.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

WALPURGITE
Probably Bi₄(UO₂)(AsO₄)₂O₄·3H₂O
U = 15.9 percent.

Waltherite (or walpurgite)
The name waltherite (1857) has priority over walpurgite (1877), but the
description of waltherite is so inadequate that the name should be
dropped.

WEEKSITE
K(UO₂)₂(Si₂O₇)·4H₂O
U = 43.4 percent.
The “gastunite” described in Am. Mineralogist, v. 44, p. 1047–1056
(1959) is weeksite.

WIDENMANNITE
Carbonate of U and Pb.
No analysis. Needs further study.

WIUKITE
Ill-defined material high in Nb, Ta, Ti, and Y, now found to be variable
mixtures of euxenite and obruchevite.
U = up to 13.2 percent; Th = up to 3.7 percent.
(1936); Bull. 149, p. 1–76 (1950).

Nuolaite
A mixture similar to wiikite.
Th = 1.8 to 3.5 percent.
Dana VII, v. 1, p. 801.

WÜLENDORFITE
(Pb, Ca)U₂O₇·2H₂O
This is “Mineral C” of Frondel (1956), now a validated species.
U = 58.1 percent.
Soc. Française Minéralogie et Cristallographie Bull., v. 82, p. 256–257
(1959).

WYARTITE
UO₂·6UO₂·2CO₂·3CaO·12–14H₂O
This was described as ianthinite (not “ianthinite français” of Bignand),
but is now recognized as a distinct species.
U = 66.8 to 67.7 percent.
Color: Violet black. Rare secondary mineral.
Am. Mineralogist, v. 40, p. 943–944 (1955); v. 44, p. 908 (1959); v. 45,
YTTRIALITE
\[(Y, \text{Th})_2\text{Si}_2\text{O}_7\]
Possibly thalenite, with much Th.
U = 0.7 to 4.0 percent; Th = 4.6 to 10.5 percent.
Color: Olive green. From granitic pegmatites.
Dana VI, p. 512.

YTTROCRASITE
\[(Y, \text{Th}, U, \text{Ca})_2\text{Ti}_4\text{O}_{11}(?)\]
U = 3.3 percent; Th = 7.3 percent.
Color: Black. From granite pegmatite.
Dana VII, v. 1, p. 793.

ZELLERITE
Ca(UO\(_2\))(CO\(_3\))\(_2\)·5H\(_2\)O
U = 44.8 percent.

ZEUNERITE
Cu(UO\(_2\))\(_2\)(AsO\(_4\))\(_2\)·10–12H\(_2\)O
U = 47.7 to 49.5 percent.

Kupferarsenuranit
Synonym of zeunerite.
Mineralog. Mag., v. 28, p. 732 (1949).

ZIPPEITE
K\(_4\)(UO\(_2\))\(_4\)(SO\(_4\))\(_3\)(OH)\(_{10}\)·H\(_2\)O
Related species contain Na, Co, Ni, Mg, Fe, or Zn.
U = 63.4 percent.
Dana VII, v. 2, p. 598.
United Nations Internat. Conf. on Peaceful Uses of Atomic Energy,

Dauberite
Possibly a synonym of zippeite.

ZIRKELITE
(Ca,Fe,Th,U\(_2\))(Ti,Nb,Zr)\(_2\)O\(_7\)(?)
U = 1.4 percent; Th = 6.4 percent.
Color: Black. From alkalic pyroxenite.
B. MINERALS WITH MINOR AMOUNTS OF URANIUM AND THORIUM

ABUKUMALITE
(Y, Th, Ca)₅(SiO₄,PO₄,AlO₄)₅(O,F)
Related to apatite.
Th= up to 0.8 percent.

ALLANITE
(Ca, Ce, Th)₃(Al, Fe, Mg)₃Si₃O₁₂(OH)
U= up to 2.95 percent, but is usually only a few hundredths of a percent.
Th= up to 4.35 percent.
Dana VI, p. 522–526.

Bagrationite
Variety of allanite.
Name also refers to cerian variety of epidote.
Dana VI, p. 518–519.

Bodenite
Related to muromontite in composition.
Dana VI, p. 526.

Bucklandite
Synonym of allanite.
Dana VI, p. 522–523, 525.

Muromontite
Apparently related to allanite but contains yttrium and beryllium.
Dana VI, p. 526.

Nagatelite
Phosphatian variety of allanite.

Orthite
Synonym of allanite.
Dana VI, p. 522–526.

Treanorite
Synonym of allanite.

Uralorthite
Synonym of allanite.
Dana VI, p. 523–525.
ALLANITE—Continued
Wasite
Altered allanite.
Dana VI, p. 526.

Xanthorite
Altered allanite.
Dana VI, p. 522–523, 525.

Yttro-orthite (or yttrium orthite)
Variety of allanite with high Y content.
Mineralog. Mag., v. 23, p. 639 (1934).

ANCYLITE
\[(\text{Ce},\text{La})(\text{Sr},\text{Ca})(\text{CO}_3)_2(\text{OH})_2\text{H}_2\text{O}\]
Th=0.18 percent.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 127.

ANGLESITE
PbSO₄
A highly radioactive anglesite, with activity presumably due to radium, has been reported.
Compare Barite, p. 52.

APATITE
\[\text{Ca}_5(\text{PO}_4)_3(\text{F},\text{OH},\text{Cl})\]
U=up to 0.08 percent in apatite from igneous rocks, but is usually less than 0.01 percent; Th=up to 0.003 percent.

Carbonate-fluorapatite
A carbonatian variety of apatite, the principal constituent of marine phosphorites, concretions, and fossil bone.
U=up to 0.85 percent, more commonly 0.005–0.02 percent.

Uran-apatite
A uranoan apatite.
U reported to be 1.4–3.3 percent. Needs further study.

BADDELEYITE
\[\text{ZrO}_2\text{ with minor Hf, Ti, and Fe}^{++}\]
May contain appreciable Th and minor U.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 125.

Brazilite
Mixture of baddeleyite, zircon, and altered zircon.
U=up to 0.8 percent.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 125.
BADDELEYITE—Continued

Caldasite
Mixture similar to brazilite.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 125.

Zirkite
Mixture similar to brazilite.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 125.

BARITE
(Ba,Pb,Ra)SO₄

Anglesobarite
Synonym of hokutolite.

Hokutolite
Plumboan variety of barite. Radioactive.
Probably contains Ra, Th, U.

Radio barite
Synonym of hokutolite.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 127.

BASTNAESITE
(Ce,La)FCO₂
U and Th present, but usually less than 1 percent.

See also Thorbastnaesite, p. 37.

Buszite
Synonym of bastnaesite.

Hydroxy bastnaesite
(Ce,La)(CO₃)(OH,F)
Th=0.44 percent.
Color: Waxy yellow to dark brown.

BRITHOLITE
(Ca,Ce)₃[(Si,P)O₄]₂(OH,F)
Apatite group.
U=up to 1.9 percent; Th=up to 17 percent but is usually less than 2 percent.

Compare Abukumalite, p. 50.

See also Fenghuanglitie, p. 18.
BRITHOLITE—Continued

Alumobritholite
An aluminum-rich britholite.
Th= up to 8.0 percent.
Color: Yellowish brown, slightly green. Occurs in pegmatites.

Pravdite
An altered britholite.

CAPPELENITE
(Ba,Ca,Ce,La,Na)₄(BO₃)₂(SiO₄)
Th= up to 0.71 percent.

CERITE
A cerium silicate with minor Ca and Fe. Formula uncertain.
U=0.4 percent; Th=0.3 percent.
See also Hydrocerite, p. 21.

CHINGLUSU ITE
A complex silicate of Na, Mn, Ca, and Ti, and contains small amounts of Th, U, and rare earths.
Th=0.05 percent; U=up to 0.39 percent.
Mineralog. Abs., v. 7, p. 222 (1938).

CORDYLITE
(Ce,La)₂Ba(CO₃)F₂
Th=0.26 percent.

CRANDALLITE
CaAl₆(PO₄)₃(OH)₅·H₂O
U=up to 0.06 percent.

Pseudowavellite
Synonym of crandallite.

DOVERITE
YFCO₃·CaCO₃(?)
Yttrium analog of synchysite(?)
U=0.18 percent; Th=1.4 percent, but monazite was present.

EPI DOTE
Ca₉(Al,Fe)₉(SiO₄)₈(OH)
U=up to 0.14 percent; Th=up to 0.05 percent.
ERIKITE
\[(La, Ce)_2(P, Si)O_7 \cdot H_2O\]
\[Th = 0.28 \text{ to } 1.01 \text{ percent.}\]
Color: Yellow green, greenish yellow. Occurs in sodalite syenite pegmatites.
The type erikite from Greenland has been shown to be monazite (Am. Mineralogist, v. 44, p. 1329 (1959)), but the Kola Peninsula mineral appears to be different.
Perhaps a silicatian rhabdophane.

FERSMITE
\[(Ca, Ce, Na)(Nb, Ti, Fe, Al)_2(O, OH, F)_4\]
\[U = 0.02 \text{ percent; } Th = 0.42 \text{ percent.}\]

FLORENcite
\[CeAl_2(PO_4)_2(OH)_8\]
Radioactivity derived from thorium present.

GADOLINITE
\[Be_2Fe_2Y_2Si_2O_10\]
\[U = \text{up to } 0.25 \text{ percent; } Th = \text{up to } 1.5 \text{ percent.}\]
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 142.
Calcio gadolinite
Variety of gadolinite.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 142.

GAGARINITE
\[Na_2Ca_2Y_3(F, Cl)_18\]
\[Th = 0.44 \text{ percent.}\]

HELLANDITE
Near Ca_5Y_4B_4Si_6O_21·3H_2O
\[Th = 0.54 \text{ to } 1.28 \text{ percent.}\]

HIBONITE
\[(Ca, R.E.*)\cdot(Al, Fe^{++}, Ti, Mg)_{11}O_{19}\]
\[U = 0.01 \text{ percent or } Th = 0.1 \text{ percent, from radioactivity.}\]

KARNASURTITE
\[(Ce, La, Th)\cdot(Ti, Nb)(Al, Fe)\cdot(Si, P)\cdotO_7(OH)_4 \cdot 3H_2O\]
Amorphous, gives a monazite-like X-ray pattern when heated.
\[Th = 2.48 \text{ to } 4.47 \text{ percent.}\]
Color: Honey to pale yellow. Occurs in sodalite syenite pegmatites.

*Rare earths.*
KARNASURTITE—Continued

Kozhanovite
Synonym of karnasurtite.

KOLM
Material resembling oil shale.
Form in which uranium is present is unknown.
U = 0.43 percent.

LOPARITE
\[(Na, Ce, Th)_{1-x} (Ti, Nb)(O_{2-x} (OH)_x)]
A member of the perovskite group.
U = up to 0.17 percent; Th = usually less than 1 percent. (For exception see irinite below.)
Color: Brown to black. Occurs in nepheline syenite pegmatite.

Irinite
A thorian loparite.
Th = 11.4 percent.

Nioboloparite
A niobian loparite.
Th = 1.0 percent.

LOVOZERITE
A complex silicate of Ti and Zr.
Th = 0.50 percent.

LUESHITE
\[(Na, Ca, Ce) (Nb, Ti)O_3]
A member of the perovskite group.
Th = up to 2.9 percent.

MELANOCERITE
Chiefly a borosilicate of the Ce and Y metals.
Th = 1.5 percent.
Dana VI, p. 414–415.

See also Caryocerite, p. 14.

MILLISITE
\[(Na, K) CaAl_6 (PO_4)_4 (OH)_8 \cdot 3H_2O]
U = 0.03 to 0.04 percent.

Pallite
A ferrian variety of millisite.
U = 0.01 to 0.015 percent.
MOSANDRITE
General formula Na₂Ca₄CeTiSi₄O₁₀(F,OH)₃
U=0.03 percent; Th=up to 0.7 percent.

Johnstrupite
Synonym of mosandrite.

Lovchorrite
Synonym of mosandrite.

Rinkite
Synonym of mosandrite.

Rinkolite
Synonym of mosandrite.

Vudyavrite
Final alteration product of mosandrite.

NATRONIOBITE
NaNbO₃
Apparently a dimorph of lueshite.
Th=0.49 percent. Occurs in dolomitic carbonatites.

NIOBO-AESCHYNITE
(Ce,Y,Ca,Fe,TH)(Nb,Ti)₂O₆
Like aeschynite but with Nb greater than Ti.
Th=2.2 percent.
Color: Black. Occurs in quartz-arfvedsonite veinlets.

PANDAITE
(Ba,Sr)(Nb,Ti)(O,OH)₇, a member of the pyrochlore group.
U=0.3 percent; Th=0.5 to 0.7 percent.

PARISITE
(Ce,La)₂Ca(CO₃)₂F₂
U=0.002 percent; Th=trace.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 127.

POLYMIGNYSTE
$ABO₄$, where $A=Ca, Fe^{+2}$, Y, Zr, Th; $B=Nb, Ti, Ta, Fe^{+3}$.
Th=3.4 percent.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 44.
POWELLITE
Ca(Mo, W)O₄
Most analyses show no U, but up to 0.57 percent U has been reported.
United Nations Internat. Conf. on Peaceful Uses of Atomic Energy, 2d,

Compare Wulfenite, p. 58.

RHABDOPHANE
(Ce,La)PO₄·H₂O

See also Erikkite, p. 54; grayite, p. 20; ninsyoite, p. 29; saryarkite, p. 35.

Silicorhabdophane
A variety of rhabdophane with high SiO₂.
Th=0.28 percent.

RIJKEBOERITE
A barium analog of microlite.
Ba₉₋₄(Ta,Nb)₂₅(O₉H₃H₂O)₇
U=1.45 percent; Th=0.17 percent.

ROWLANDITE
(Y, Ce, Fe)₆(SiO₄)₃(F, OH) (?)
Possibly a metamict thalenite.
U=0.4 percent.
Dana VI, p. 1047.

SPENCITE
Perhaps (Y, Ce, Ca, Th)₄Ba₂Si₆O₁₆
Th=2.1 to 2.2 percent; U=0.75 percent.

SPHENE
CaTiSi(O₂H,F)₅
U=up to 0.14 percent; Th=up to 0.65 percent.

Titanite
Synonym of sphene.

STILLWELLITE
(Ca, Ce)(Si, Al, P)B(O₂H,F)₅
U=0.19 percent; Th=0.05 percent.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials,
1958, p. 148.

SYNCHYSITE
(Ce, La)Ca(CO₃)₂F
Th=0.26 percent.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials,
1958, p. 127.
GLOSSARY OF URANIUM- AND THORIUM-BEARING MINERALS

TENGERITE
CaY\(_3\)(CO\(_3\))\(_4\)(OH)\(_4\)·3H\(_2\)O(?)
The originally described tengerite (Dana VI, p. 306-307) is a different mineral, supposedly beryllium yttrium carbonate; no published analysis.
Th=0.3 percent.
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 127.

THALENITE
Y\(_2\)Si\(_2\)O\(_7\)
Related to yttrialite.
Th=0.16 percent.
Dana VI, app. I, p. 68.

TUNDRITE
Ce\(_2\)Ti(Si,P)(O,OH)\(_7\)-4H\(_2\)O
Further work is needed on this mineral.
Th=0.69 percent.

Titanorhabdophane
Synonym of tundrite.

TURANITE
Supposedly Cu\(_5\)(VO\(_4\))\(_2\)(OH)\(_4\)
May be related to mottramite.
Reported to contain 3.2 percent U.

VANOXITE
Perhaps 2V\(_2\)O\(_4\).V\(_2\)O\(_5\).8H\(_2\)O
Reported to contain up to 0.42 percent U; species may be invalid; analysis was made on a mixture (Weeks, A. D., written commun., 1960).

VESUVIANITE (or idocrase)
Ca\(_{10}\)(Mg,Fe)\(_2\)Al\(_2\)(SiO\(_4\))\(_3\)(Si\(_2\)O\(_7\))\(_2\)(OH)\(_4\)
Not usually reported to contain U and Th, but a metamict variety is reported from nepheline syenite pegmatite.
U=0.85 percent; Th=0.47 percent.

WULFENITE
Pb(Mo,U)O\(_4\)
Most analyses show no U, but up to 9.65 percent U has been reported. Color: Orange, yellow, brown. A secondary mineral.

XENOTIME
YP\(_4\)
U=up to 3.6 percent; Th=up to 2.2 percent.
MINERALS WITH MINOR AMOUNTS OF U AND TH

YTTROTANTALITE
(Fe, Y, U)(Nb, Ta)O₄
Grades to samarskite.
U = as much as 4.8 percent; Th = as much as 2.2 percent.

Yttrocolumbite
Similar to yttrotantalite.

YTTROTUNGSTITE (or thorotungstite)
Y₂W₄O₁₁·4H₂O
Th = up to 0.07 percent.

ZIRCON
ZrSiO₄
U and Th low in most specimens, but as much as 2.7 percent U and 13.1 percent Th reported.
Dana VI, p. 482–486.

Alvite
Variety of zircon near cyrtolite.
Dana VI, p. 487–488.

Arshinovite
Variety of zircon.
U = several tenths of one percent.

Azorite
Variety of zircon.
Dana VI, p. 482–484.

Calyptolite
Probably altered zircon.
Dana VI, p. 482, 486.

Cyrtolite
Altered zircon, containing U, Th, Y and other rare earths.
Dana VI, p. 487.

Hagatalite
Synonym of zircon.
Am. Mineralogist, v. 11, p. 137 (1926).

Hoeftveitite
May be alvite.

Malacon
Hydrated or altered zircon.
Dana VI, p. 486.
ZIRCON—Continued

Naegite
Variety of zircon.
Mineralog. Abs., v. 2, p. 36 (1923).

Oerstedite
Altered zircon.
Dana VI, p. 486.

Oyamalite
Variety of zircon.

Ribeirite
An yttrian zircon.

Tachyapaltite
Probably altered zircon.
Dana VI, p. 486.

Yamagutilite (or yamaguchilite)
Variety of zircon.
Contains $P_2O_5$ and rare earths.
Mineralog. Mag., v. 24, p. 626 (1937).

ZIRCONOLITE
$(Ca,Ce)Zr(Ti,Nb)O_7$
$U=\text{up to }1.49\text{ percent}; \text{Th}=\text{up to }0.51\text{ percent}.$

Niobozirconolite
A niobium-rich zirconolite.
$U=0.34\text{ percent}, \text{Th}=2.5\text{ percent}.$
C. MINERALS REPORTED TO CONTAIN URANIUM AND THORIUM MINERALS AS IMPURITIES OR INTERGROWTHS

ADAMITE
\[ \text{Zn}_2(\text{OH})(\text{AsO}_4) \]
Reported to contain small amounts of U.
Mineralog. Abs., v. 10, p. 375 (1948).

ALLOPHANE
\[ \text{Al}_2\text{O}_3\cdot\text{SiO}_2\cdot\text{nH}_2\text{O} \]
Reported by R. G. Coleman (written commun., 1960) to contain up to 0.91 percent U.
*Compare* Evansite, p. 62; opal, p. 63.

BOBENBENDERITE
Mixture of fluorite and spessartite.
\[ \text{U}=0.11 \text{ percent.} \]
Am. Mineralogist, v. 34, p. 608-611 (1948).

CALCIOVOLBORTHITE
\[ \text{CaCu(VO}_4\text{)}(\text{OH}) \]
Reported to contain 3.1 percent U.
*Tangeite* (or *tangueite*)
Synonym of calciovolborthite.

CHRYSOCOLLA
\[ \text{CuSiO}_3\cdot2\text{H}_2\text{O} \]
\[ \text{U}=0.03 \text{ percent.} \]
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 530.
*Katangite*
Synonym of chrysocolla.
May contain U in admixture.
Mineralog. Abs., v. 9, p. 23 (1946).

COLUMBITE
\[ (\text{Fe, Mn})(\text{Nb, Ta})_2\text{O}_6 \]
\[ \text{U}=\text{up to 9.8 percent.} \]
*Baierite* (or *baierine*)
Synonym of columbite.
Dana VII, v. 1, p. 780.
*Dianite*
Synonym of columbite.
Dana VII, v. 1, p. 780.
COLUMBITE—Continued

Ferrocolumbite
Synonym of columbite.
Dana VII, v. 1, p. 780, 783.

Ferro-ilmenite
Synonym of columbite.
Dana VII, v. 1, p. 780, 785.

Greenlandite
Synonym of columbite.
Dana VII, v. 1, p. 780, 784.

Hermannolite
Synonym of columbite.
Dana VII, v. 1, p. 780, 785.

Manganocolumbite
Variety of columbite.
Dana VII, v. 1, p. 700, 783–784.

CORVUSITE
\[ V_2O_4·6V_2O_5·xH_2O \]
\[ U = \text{up to 2.5 percent.} \]
Work in progress indicates species may be valid.
Reexamination of type material shows presence of rauvite, which might account for reported uranium content (Weeks, A. D., written commun., March 1952).

CRYPTOMELANE
\[ (K, Ba)(Mn, Fe)_8O_{16} \]
Reported to contain up to 1 percent U.

EVANSITE
\[ Al_6(OH)_4PO_4·6H_2O \]
Reported to contain small amounts of U and Th.
Mineralog. Abs., v. 10, p. 375 (1948).

FLUORITE
\[ CaF_2 \]
Some specimens, especially deep purple ones, are radioactive. This generally can be shown to be due to inclusions of uranium minerals, but the fluorite itself possibly may have U in substitution for Ca.
Strong alpha bombardment produces the semiopaque black variety antozonite, as in the inner bands of halos surrounding uraninite and thorite inclusions. Centered thorium halos in fluorite have a maximum radius of about 41 microns. Uranium halos are smaller with a maximum radius of about 31 microns.
HYDROZINCITE

\[2\text{ZnCO}_3\cdot3\text{Zn(OH)}_2\]

U = 0.07 percent.

Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 530.

LIMONITE

Cryptocrystalline goethite, \(\text{FeO(OH)}\), with adsorbed or capillary water. 

U = 0.03 percent.

Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 530.

OPAL

\[\text{SiO}_2\cdot\text{nH}_2\text{O}\]

Some varieties, particularly hyalite, show a green fluorescence due to uranium content. 

U = usually 0.05 percent; however, up to 0.9 percent U has been reported in silica sinters from hot springs. 


PYROMORPHITE

\[\text{Pb}_5(\text{PO}_4)_3\text{Cl}\]

Some specimens are uraniferous. 


SCAPOLITE

\[(\text{Na, Ca})_4\text{Al}_3(\text{Al, Si})_6\text{Si}_8\text{O}_{24}(\text{Cl, CO}_3, \text{SO}_4)\]

Chemie der Erde, v. 9, p. 139–144 (1934).

SEFSTRÖMITE

A mixture of ilmenite with minor amounts of radioactive minerals. 

Dana VII, v. 1, p. 542. 

Mineralog. Mag., v. 29, p. 112 (1950).

TANTALITE

\[(\text{Fe}, \text{Mn})(\text{Ta}, \text{Cb})_2\text{O}_6\]


Olovotantalit (or tintantalite)

Unnecessary name for stannian mangano-tantalite. 

U = 0.03 percent. 


TURQUOISE

Perhaps \[\text{H}_3(\text{CuOH})[\text{Al(OH)}_2]_6(\text{PO}_4)_4\]

U = up to 0.005 percent. 


VARISCITE

\[\text{AlPO}_4\cdot2\text{H}_2\text{O}\]

U = up to 0.005 percent. 

WAVELLITE
\[ \text{Al}_2(\text{PO}_4)_2(\text{OH})_2\cdot 5\text{H}_2\text{O} \]
\[ \text{U=up to 0.004 percent.} \]
Heinrich, E. W., Mineralogy and geology of radioactive raw materials, 1958, p. 130.

Fischerite
Probably is wavellite; reported to contain small amounts of U.
Mineralog. Abs., v. 10, p. 375 (1948).
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[Valid mineral species in boldface]

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