NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

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STATE BUREAU OF MINES AND MINERAL RESOURCES

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TABLES OF FLUORESCENT AND RADIOACTIVE MINERALS

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FLUORESCENCE

During the past few years prospecting in New Mexico has expanded so as to include many minerals besides gold, silver, and the common base metals. The use of fluorescent light has helped to expand the field for both the prospector and the technical engineer. The New Mexico Bureau of Mines and Mineral Resources arranged for the writer to compile the attached tables illustrating the behavior of minerals under ultra-violet light, for the use of prospectors and other interested persons.

Some minerals have the property of emitting light of different colors while they are exposed to direct radiation such as ultra-violet rays. If the emission of light lasts only as long as the mineral is exposed to direct radiation, the mineral is said to be fluorescent; if the emission lasts after the direct radiation has been cut off, the mineral is said to be phosphorescent. These tables refer only to the property of fluorescence.

The wave lengths of ultra-violet light are measured in Angstrom units (A.U.), which are fractions of a centimeter or more exactly .0000001 millimeter. Rays with wave lengths shorter than 3100 A.U. are short rays. Such rays are obtained from cold quartz tubes. The cold quartz tube is useful because it can be built in a portable unit and can be used very conveniently for prospecting in the field.

Rays with wave length longer than 3100 A.U. are long rays. These rays are obtained from heat-generating units such as arc lamps, and are generally used only in laboratory work. Black Bulb, Black Light, and Wonder Light are convenient sources of long waves.

There are many manufacturers of the portable or laboratory ultraviolet units. One can find dealers in such units in many big cities. A few such dealers are listed below:

(1) W. H. Curtin & Company, P. O. Box 118, Houston, Texas

(2) Central Scientific Company, 3555 Whittier Blvd., Los Angeles 23, California

(3) Eberbach & Son Company, Ann Arbor, Michigan

(4) The Denver Fire Clay Company, 121 North 7th Street, or P. O, Box 497, Albuquerque, New Mexico

(5) Fisher Scientific Company, 2850 South Jefferson, St. Louis 18, Missouri

(6) Braun Corporation, 2260 East 15th Street, Los Angeles 21, California

(7) Ward's Natural Science Establishment, Inc., 3000 Ridge Road East, Rochester 9, New York

FLUORESCENT MINERALS

Note:

(1) Minerals marked with an asterisk (*) are radioactive·

(2) A double asterisk (**) indicates that the fluorescent color is not obtainable from the references consulted.

(3) Minerals which have been found in New Mexico are capitalized.

NAME	CHEMICAL FORMULA.	COLOR UNDER SHORT RAY	COLOR UNDER LONG RAY	REACTION
AGATE (gem)	SiO_2	Strong green		Good
Alexandrite (gem)	$BeAl_2O_4$	**		Fair
Aluminite	$Al_2O_3 \cdot SO_3 \cdot 9H_2O$	White	White	Fair
ALUNITE	$K2Al6\ (OH)_{12}(SO4)_4$	White		Fair
Amber (gem)	Hydrocarbon	Yellow-green to blue-white		Fair
AMAZONITE (gem)	$KAlSi_3O_8$	Dirty pale green		Fair
AMETHYST (gem)	SiO_2	Green		Fair
ANGLESITE	$PbSO_4$	Yellow	Yellow	Fair
ANORTHOCLASE	$(Na,K)AlSi_3O_8$	Blue		Fair
APATITE (See Fluorapatite)				

APOPHYLLITE	$KF{\cdot}Ca_4(Si_2O_5)4{\cdot}8H_2O$	Yellowish		Fair
ARAGONITE	$CaCO_3$	Fire-red, cream-white	Pink, green	Good
AUTUNITE*	$CaO{\cdot}2UO_3{\cdot}P_2O_5{\cdot}8H_2O$	Strong yellow-green	Strong yellow-green	Good
AXINITE	$HCa_3Al_2BSi_4O_{16}$	Red	Red	Fair
BARITE	$BaSO_4$	**	**	Fair
	(Generally not fluorescent)			
Barylite	$Be_2BaSi_2O_7$	Blue		Fair
BASSETITE*	$CaO{\cdot}2UO_3{\cdot}P_2O_5{\cdot}8H_2O$	Strong yellow-green	Strong yellow-green	Fair
Benitoite (gem)	$BaTiSi_3O_9$	**	**	Fair
BERYL (gem)	$Be_3Al_2(SiO_3)_6$	Very dark green	Very dark green	Fair
BORAX	$Na_2B_4O_7{\cdot}10H_2O$		Greenish	Fair
BRUCITE	$Mg(OH)_2$	**	‡‡	Fair
CALCITE	$CaCO_3$	Red		Good
Calcium-larsenite	$(Pb,Ca)ZnSiO_4$	strong yellow		Good
CARNELIAN (gem)	SiO_2	Dull purple		Good
CELESTITE	$SrSO_4$	White		Fair
CERUSSITE	$PbCO_3$	Pale Blue	Yellow	Fair
CHALCEDONY	SiO_2	Strong green, variable		Good

CHALCOCITE	Cu_2S	**	**	Fair.
Chrysoberyl (gem)	$BeAl_2O_4$	**	**	Fair
CHRYSOPRASE (gem)	SiO_2	Strong greem		Fair
Clinohedrite	$H_2CaZnSiO_5$	Bright orange	Pink	Good
Colemanite	$Ca_2B_6O_{11}\cdot 5H_2O$		Green	Good
Cuproscheelite	$(Ca,Cu)WO_4$	Dull green		Good
Curtisite	Hydrocarbon	Yellowish green	Yellowish green	Good
Diamond (gem)	Carbon	**	**	Fair
DOLOMITE	CaMg(CO3)	White	White, blue-white	Fair
Elaterite	Hydrocarbon		Brown	Fair
EPSOMITE	$MgSO_4\cdot 7H_2O$		Pale blue	Fair
EMERALD (gem)	$Be_3Al_2(SiO_3)_6$	Very dark green	Very dark green	Fair
FLUORITE	CaF_2		Blue	Good
FLUORAPATITE	$(CaF)Ca_4(PO_4)_3$	Orange		Fair
GARNET (gem)	$3RO\cdot R_2O_3\cdot 3SiO_2$	Dull purple	Dull purple	Fair
Gay-Lussite	$Na_2CO_3\cdot CaCO_3\cdot 5H_2O$		Pink	Fair
GYPSUM	$CaSO_4\cdot 2H_2O$		Green	Good
Gyrolite	$H_2Ca_2Si_3O_9H_2O$	White	White	Fair
Hackmanite	Variety of sodalite	Pale pink	Pale pink	Good

HALITE	$NaCl$	Vivid red		Good
Hexagonite	$CaMg_3(SiO_4)_3$	Red	Pink	Fair
Hiddenite	$LiAl(SiO_3)_2$		Weak orange	Pair
HYDROMAGNESITE	$MgCO_3 \cdot Mg(OH)_2 \cdot 3H_2O$		Greenish	Fair
HYDROZINCITE	$3ZnCO_3 \cdot 3Zn(OH)_2$	Vivid blue		Good
HYALITE (gem)	$SiO_2 \cdot nH_2O$	Yellow-green		
Jade (gem)	$Ca_2(Mg,Fe)_5(OH)_2(Si_4O_{11})_2$	Dark green bright streaks	Dark green bright streaks	Fair
Johannite*	$(Cu,Fe,Na_2)O \cdot UO_3 \cdot SO_3 \cdot 4H_2O$	Characteristic yellow-green	Characteristic yellow-green	Fair
Kunzite (gem)	$LiAl(SiO_3)_3$		Weak orange	Fair
Lanthanite	$(La,Di,Ce)_2(CO_3)_3 \cdot 8H_2O$	**	**	Fair
LEUCITE	$KAl(SiO_3)_2$		Orange	Fair
Meta-torbernite*	$Cu(UO_2)_2P_2O_8 \cdot 8H_2O$	Characteristic yellow-green	Characteristic yellow-green	Good
Masonite	$Pb_4(PbCl)_2Ca_4(Si_2O_7)_3$	Blue		Fair
OPAL (gem)	$SiO_2 \cdot nH_2O$	Green		Good
OPAL*	$SiO_2 \cdot nH_2O$	Strong bright green		Good
Ozocerite	Hydrocarbon	Yellowish		Fair
PECTOLITE	$HNaCa_2(SiO_3)_3$	Yellow		Good
PERIDOT (gem)	$(Mg,Fe)_2SiO_4$	Dark brown to green	Dark brown to green	Fair

PETROLEUM	Hydrocarbon	Yellowish green	Yellowish green	Good
PITCHBLENDE	Uranium oxide	Yellowish green	Yellowish green	Fair
POWELLITE	$Ca(Mo,W)O_4$	Yellowish white		Good
Priceite	$5CaO{\cdot}6B_2O_3{\cdot}9H_2O$	Yellowish		Fair
PYROMORPHITE	$(PbCl)Pb_4(PO_4)_3$		White	Fair
QUARTZ (gem)	SiO_2	Strong green		Good
Ruby (gem)	Al_2O_3	Weak red to wine-red	Weak red to wine-red	Fair
Sapphire (gem)	Al_2O_3	Weaker than ruby	Weaker than ruby	Fair
SCAPOLITE	$CaCO_3{\cdot}3CaAl_2Si_2O_8$ to $NaCl{\cdot}3NaAlSi_3O_8$	Moderate yellow	Vivid yellow	Good
SCHEELITE	$CaWO_4$	Blue		Good
Schroeckingerite* (Dakeite)	Hydrous U carbonate	Yellowish green	Yellowish green	Good
SELENITE	$CaSO_4{\cdot}2H_2O$		Green	
SMITHSONITE (gem)	$ZnCO_3$	Blue-green	Green	Good
SODALITE	$3NaAlSiO_4{\bullet}NaCl$	Pale pink	Pale pink	Fair
SPHALERITE (gem)	ZnS		Strong orange	Good
SPINEL (gem)	$MgAl_2O_4$	Weak red to wine-red	Weak red to wine-red	Fair
STRONTIANITE	$SrCO_3$	White		Fair

SULFUR	S		Yellowish	Fair
Thaumasite	$CaSiO_3 \cdot CaCO_3 \cdot CaSO_4 \cdot 15H_2O$	White		Fair
TOPAZ (gem)	[Al(F,OH)2]AlSiO4	Weak yellow		Fair
TORBERNITE	$Cu(UO_2)_2P_2O_8 \cdot 12H_2O$	Characteristic yellow-green	Characteristic yellow-green	Good
TOURMALINE (gem)	$H_9Al_3(B \cdot OH)_2Si4O_{19}$	**	**	Fair
TRAVERTINE	$CaCO_3$	Vivid red		Fair
TRONA	$Na_2CO_3 \cdot HNaCO_3 2H_2O$	Blue	Blue	Fair
TURQUOIS (gem)	$CuO \cdot 3Al_2O_3 \cdot 2P_2O_5 \cdot 9H_2O$	Mouse-gray	Mouse-gray	Fair
VESUVIANITE	$Ca_6[Al(OH,F)]Al_2(SiO_4)_5$		Yellowish	Fair
Wavellite	$4AlPO_4 \cdot 2Al(OH)_3 \cdot 9H_2O$		Green	Fair
WERNERITE	Variety of scapolite	Moderate yellow	Vivid yellow	Good
WILLEMITE	Zn_2SiO_4	Green	Green	Good
WITHERITE	$BaCO_3$		Yellow	Fair
WOLLASTONITE	$CaSiO_3$	Yellowish orange		Good
Zippeite*	$2UO_3 \cdot SO_3 \cdot H_2O$	Characteristic yellow-green	Characteristic yellow-green	Good
ZIRCON (gem)	$ZrSiO_4$	**	**	Fair

RADIOACTIVITY

Radioactivity is a phenomenon of substances which emit naturally particular radiations. The fundamental nature of radioactivity is such that the atoms of a substance will undergo a transformation spontaneously into atoms of another element. During such transformation, energy is released by the substance in the form of various types of radiation. The major types of such radiations are (1) alpha rays, nuclei of helium atoms; (2) beta rays, negative electrons emitted by the nucleus; and (3) gamma rays, an electromagnetic radiation. A chemical element that exhibits the phenomenon of radioactivity is termed radio-element; minerals that contain these radio-elements are radioactive minerals. If the probability of the atoms of a substance undergoing transformation and emitting various types of radiation is very small, such substance is either stable or weakly radioactive· If such probability is large, the substance will be strongly radioactive.

There are three types of instruments for the detection and measurement of radioactivity. The most common and popular type is the Geiger-Muller counter, commonly known as Geiger counter. The second type is the scintillation counter, or commonly known as scintillator. The third type is the ionization chamber which is not commonly used in prospecting. There are various kinds of Geiger counters on the market, such as "Lucky Strike Geiger Counter," "Professional Geiger Counter," "Drill Hole Geiger Counter and Snooper-Geiger Counter." Also there are various kinds of

scintillation counters, such as "Royal Scintillator," "Super Scintillator," "Special Scintillator," etc· The price of the counters ranges from less than $50 to over $1,000. The sensitivity of these counters also varies greatly. Usually only the gamma rays can be detected by Geiger counter· The alpha and beta rays are very weak and can easily be stopped by the wall of the counter. A scintillation counter is usually about 100 times as sensitive as a Geiger counter. A prospector can be misled when he retires his old Geiger counter and begins to use a more expensive and sensitive scintillation counter, because many kinds of rocks (not uranium ore) will exhibit a "high" radioactivity in his new scintillation counter. It is important to understand thoroughly the function and sensitivity of a counter, and to interpret correctly the reading of the counter in terms of U_3O_8 percentage· The following two booklets are good references for those who are interested in prospecting with a counter.

(1) Prospecting for uranium, published by the U. S. Atomic Energy Commission and the U. S. Geological Survey· Price 55 cents.

(2) Prospecting with a counter, by Robert J. Wright, U. S. Atomic Energy Commission. Price 30 cents.

These booklets can be purchased from:

(1) Superintendent of Documents, Government Printing Office, Washington 25, D. C.

(2) New Mexico Bureau of Nines and Mineral Resources, Campus Station, Socorro, New Mexico.

RADIOACTIVE MINERALS

Note: (l) Radioactive minerals are mainly uranium and thorium minerals.

(2) Minerals which have been found in New Mexico are capitalized.

(3) Minerals which contain only a small amount of uranium or thorium as impurities or intergrowths are listed at the end of this table. Many varieties and doubtful minerals are not included.

MINERAL	CHEMICAL FORMULA
Abernathyite	$K_2(UO_2)_2\ (AsO_4)_2 \cdot 8H_2O$
Abukulalite	$(Th,Ca,Y)_5\ (SiO_4,PO_4,AlO_4)_3(O,F)$
ALLANITE	$(Th,Ca,Ce)_2(Al,Fe,Mg)_3Si_3O_{12}(OH)$; U=0.02%
Ampangabeite	$(Y,Er,U,Ca,Th)_2(Nb,Ta,Fe,Ti)_7O_{18}$?
Andersonite	$Na_2Ca(UO_2)\ (CO_3)_3 \cdot 6H_2O$
Anthraxolite	A Ni- and U-hydrocarbon; U=0.003%
ASPHALTITE	Solid bituminous hydrocarbon with 0.001% and up U.
AUTUNITE	$Ca(UO_2)_2(PO_4)_2 \cdot 10\text{-}12H_2O$
Bassetite	$Fe(UO_2)2(PO_4)_2 \cdot 8H_2O$
BASTNAESITE	$(Ce,La)CO_3F$; U and Th present but less than 1%
Bayleyite	$Mg_2(UO_2)\ (CO_3)_3 \cdot 18H_2O$
Becquerelite	$7UO_3 \cdot 11H_2O$
Betafite	$(U,Ca)\ (Nb,Ta,Ti)_3O_2 \cdot nH_2O$?
BETA-URANOPHANE	$Ca(UO_2)\quad (SiO_3)\ (OH)_2 \cdot 5H_2O$
Billietite	$BaO \cdot 6UO_3 \cdot 11H_2O$
Brannerite	$(U,Ca,Fe,Y.Th)_3(Ti,Si)_5O_{16}$?
Calciosamarskite	$(Ca,X,U,Th)_3(Nb,Ta,Fe,Ti,Sn)_5O_{15}$?
Cappelenite	$Ba(Y,Ce,La)_6B_6O_{12}(OH)_2(SiO_4)_3$; Th=0.42%
Carbonate-fl	Contains U up to 0.02%
CARNOTITE	$K_2(UO_2)_2(VO_4)2 \cdot 3H_2O$

Cerite	A cerium silicate containing a small amount of Th & U.
Chinglusuite	A complex silicate with a small amount of Th and rare earths.
Clarkeite	$(Na,K)_{2-2x}(Ca,Pb)_xU_2O_7 \cdot yH_2O$
Coffinite	$U(SiO_4)_{1-x}(OH)_{4x}$
Cordylite	$(Ce,La)_2Ba(CO_3)_3F_2$; Th=0.26%
CUPROSKLODOWSKITE	$Cu(UO_2)_2(SiO_3)_2(OH)_2 \cdot 5H_2O$
Curite	$3PbO \cdot 8UO_3 \cdot 4H_2O$
Davidite	$AB_3(O,OH)_7$ or AB_5O_7; U=4.4%; Th=0.12%; A= Fe_2,U_6 Ca,Zr,Th, rare earths; B= Ti,Fe_3,V,Cr
Delorenzite	$(Y,U,Fe_2)(Ti,Sn?)_2O_8$? U=8.7%
Dewindtite	$Pb_3(UO_2)_5(PO_4)_4(OH)_4 \cdot 10H_2O$
Dumontite	$Pb_2(UO_2)_3(PO_4)_2(OH)_4 \cdot 3H_2O$
Epiianthinite	$yUO_3 \cdot xH_2O$
Eschynite	$(Ce,Ca,Fe_2,Th)(Ti,Nb)_2O_6$
EUXENITE	$(Y,Ca,Ce,U,Th)(Nb,Ta,Ti)_2O_6$
Ferghanite	$U_3(VO_4)_2 \cdot 6H_2O$?
FERGUSONITE	$(Y,Er,Ce,Fe)(Nb,Ta,Ti)O_4$
Fersmite	$(Ca,Ce,Na)(Nb,Ti,Fe,Al)_2(O,OH,F)_6$
Formanite	$(Y,U,Th,Ca)(Ta,Nb,Ti)O_4$
Fourmarierite	$PbU_4O_{13} \cdot 7H_2O$
Fritzcheite	$Mn(UO_2)_2(P,V)_2O_8 \cdot 8H_2O$?
GUMMITE	An altered Uraninite
Hielmite	$(Y,Fe_2,U_4,Mn,Ca)(Nb,Ta,Sn,W)_2O_6$
Huttonite	$ThSiO_4$
Ianthinite	$2UO_2 \cdot 7H_2O$?
Irinite	$(Na,Ce,Th)_{1-x}(Ti,Nb)[O_{3-x}(OH)_x]$

Ishikawaite	$(U,Fe,rare\text{-}earths)(Nb,Ta)O_4$
Johannite	$Cu(UO_2)_2(SO_4)_2(OH)_2 \cdot 6H_2O$
Kasolite	$Pb(UO_2)SiO_4 \cdot H_2O$
Kahle rite	$Fe(UO_2)_2(AsO_4)_2 \cdot nH_2O$
Khlopinite	$(Y,U_4,Th)_3(Nb,Ta,Ti,Fe)_7O_{20}$?
Kolm	U-bearing oil shale
Liebigite	$Ca_2(UO_2)(CO_3)_3 \cdot 10\text{-}11H_2O$
Lovchorrite	$Ce_2(TiO_3)_3 \cdot 10CaS$; $O_3 \cdot 2CeF_3$; U up to .03%, Th up to .7%
Lovozerite	Complex silicate of Ti and Zr, with a little Th
Masuyite	$UO_3 \cdot 2H_2O$
Meta-Autunite I	$Ca(UO_2)_2(PO_4)_2 \cdot 2½\text{-}6½H_2O$
METATORBERNITE	$Cu(UO_2)_2(PO_4)_2 \cdot nH_2O$; n= 4 to 8
Metatyuyamunite	$Ca(UO_2)_2(VO_4)_2 \cdot 5\text{-}7H_2O$
Meta-Uranocircite	$Ba(UO_2)_2(PO_4)_2 \cdot 8H_2O$
Meta-Uranopilite	$(UO_2)_6(SO_4)(OH)_{10} \cdot 5H_2O$?
Metazeunerite	$Cu(UO_2)_2(AsO_4) \cdot 8H_2O$
MICROLITE	$(Na,Ca)_2(Ta,Nb)_2O_6(O,OH,F)$; U= up to 10.4%; Th= up to .2%
MONAZITE	(Ce,La,Th)PO
Mosandrite	Complex silicate of Na,Ca,Ce, and Ti; Th=.3%
Nohlite	$(Ca,Mg,Fe^2,X,U)_2(Nb,Zr,Fe^3)_3O_{10}$; X=rare-earths
Novacekite	$Mg(UO_2)_2(AsO_4)_2 \cdot 8\text{-}10H_2O$
Parsonsite	$Pb_2(UO_2)(PO_4)_2 \cdot 2H_2O$
Phosphuranylite	$Ca_3(UO_2)_4(PO_4)_2(OH)_4 \cdot 7H_2O$
Pilbarite	$Pb \cdot UO_3, ThO_2 \cdot 2SiO_2 \cdot 4H_2O$
Pisekite	Niobate-tantalate-titanate of U and rare-earths
PITCHBLENDE	Altered fine-grained variety of uraninite

Polycrase	$(Y,Ca,Ce,U,Th)(Ti,Nb,Ta)_2O_6$
Polymignyte	$(Ca,Fe^2,Y,Zr,Th)(Nb,Ti,Ta)O_4$
Priorite	$(Y,Er,Ca,Fe^2,Th)(Ti,Nb)_2O_6$; U up to 3·4%
Pyrochlore	$(Na,Ca)_2(Nb,Ta)_2O_6F$; U up to 1.4%; Th up to 4.4%
Rauvite	$CaO·2UO_3·5V_2O_5·16H_2O$?
Renardite	$Pb(UO_2)_4(PO_4)_2(OH)_4·7H_2O$
Rinkite	$Ce_2(TiO_3)_3·10CaSiO_3·3CaF_2$
Rowlandite	$(Y,La,Ce)_4Fe(F,Si_2O_7)_2$?
Rutherfordine	UO_2CO_3
Sabugalite	$HAl(UO_2)_4(PO_4)_4·16H_2O$
Saleeite	$Mg(UO_2)_2(PO_4)_2·8\text{-}10H_2O$
SAMARSKITE	$(Y,Ce,U,Ca,Fe,Pb,Th)(Nb,Ta,Ti,Sn)_2O_6$
Schoepite	$UO_3·2H_2O$
Schroeckingerite	$NaCa_3(UO_2)(CO_3)_3(SO_4)F·10H_2O$
Sengierite	$Cu(UO_2)(VO_4)(OH)·4\text{-}5H_2O$
Sharpite	$(UO_2)_6(CO_3)_5(OH)_2·7H_2O$?
SKLODOWSKITE	$Mg(UO_2)_2(SiO_3)_2(OH)_2·6H_2O$
Soddyite	$(UO_2)_5(SiO_4)_2(OH)_2·5H_2O$
Swartzite	$CaMg(UO_2)(CO_3)_3·12H_2O$
Thalenite	$Y_4Si_4O_{13}(OH)_2$
Thorianite	$(Th,U)O_2$
THORITE	$ThSiO_4$
Thorogummite	$Th(SiO_4)_{1-x}(OH)_{4x}$
Thucholite	Hydrocarbons with uraninite
TORBERNITE	$Cu(UO_2)_2(PO_4)_2·12H_2O$
Tritomite	A borosilicate of Ce,Y,Ca,Th, and F: Th up to 8.3%

Troegerite	$H^2(UO_2)_2(AsO_{14})_2 \cdot 8H_2O$?
Tscheffkinite	Silicate of rare-earths, Fe, Mn, Mg, Ca, Al, Ti, Th, and U
TYUYAMUNITE	$Ca(UO_2)_2(VO4)_2 \cdot nH_2O$
URANINITE	Ideally UO_2
URANOPHANE	$Ca(UO_2)_2(SiO_3)_2(OH)_2 \cdot 5H_2O$
Uranopilite	$(UO_2)_6(SO_4)(OH)_{10} \cdot 12H_2O$
Uranospathite	$Cu(UO_2)_2(AsO_4,PO_4)_2 \cdot 11H_2O$?
Uranosphaerite	$(BiO)\ (UO_2)(OH)_3$?
Uranospinite	$Ca(UO_2)_2(AsO)_2 \cdot 10H_2O$
Uvanite	$U_2V_6O_{21} \cdot 15H_2O$
Vandenbrandeite	$CuUO_4 \cdot 2H_2O$
Vandendriesscheite	$PbO \cdot 7UO_3 \cdot 12H_2O$
Voglite	$Ca_2CuU(CO_3)_5 \cdot 6H_2O$?
Volborthite	$Cu_3(VO_4)_2 \cdot 3H_2O$; U up to 3.l%
Walpurgite	$Bi_4(UO_2)(AsO_4)_2O_4 \cdot 3H_2O$
Xenotime	YPO_4; U up to 3.6%; Th up to 2.2%
Yttrialite	Silicate of Th and Y, possibly thalenite with much Th. U up to 0.8%
Yttrocrasite	$(Y,Th,U,Ce)_2Ti_4O_{11}$?
Zippeite	$2UO_3 \cdot SO_3 \cdot 5H_2O$?
ZIRCON	$ZrSiO_4$; U up to 2.7%; Th up to 13,l%
Zirkelite	$(Ca,Fe,Th,U)_2(Ti,Zr)_2O_5$?

The following minerals may contain some uranium and thorium as impurities or intergrowths:

Adamite	$Zn_2(OH)AsO_4$
Ambatoarinite	Carbonate of Sr and rare-earths

Ancylite	$(Ce,La)_4(Sr,Ca)_3(CO_3)_7(OH)_4 \cdot 3H_2O$
Baddeleyite	ZrO_2
Bazzite	Silicate of scandium, with Fe,Na, and rare-earths
COLUMBITE	$(Fe,Mn)(Nb,Ta)_2O_6$
Corvusite	$V_2O_4 \cdot 6V_2O_5 \cdot nH_2O$
CYRTOLITE	Altered zircon
Fischerite	$Al_2(OH)_3PO_4 \cdot 2½H_2O$
FLUORITE	$CaFO_3$ purple fluorite in New Mexico usually contains a small amount of U
Kalkowskite	$Fe_2Ti_3O_9$?
OPAL	$SiO_2 \cdot nH_2O$; some green varieties in New Mexico may contain up to .10% U_3O_8
PYROMORPHITE	$Pb_5(PO_4)_3Cl$
SCAPOLITE	$(Na_3Ca)_4Al_3(Al,Si)_3Si_6O_{24}(Cl,CO_3,SO_4)$
TANTALITE	$(Fe,Mn)(Ta,Nb)_2O_6$
Turanite	$Cu_5(VO_4)_2(OH)_4$?
Volborthite	$Cu_3(VO_4)_2 \cdot 3H_2O$?

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