

DURANGITE FROM THE BLACK RANGE, NEW MEXICO, AND NEW DATA ON DURANGITE FROM DURANGO AND CORNWALL

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ABSTRACT

Durangite, ideally $\text{NaAl}(\text{AsO}_4)\text{F}$, previously reported from only three occurrences and verified from only two of these, has been found at two locations in the Black Range, Sierra County, New Mexico. It is associated with hematite, cassiterite, \pm clinopyroxene, cristobalite, tridymite, quartz, fluorite, \pm beudantite, montmorillonite and todorokite in rhyolite ash-flow tuffs and flows. The mineral occurs as transparent to semi-opaque, pale yellow to medium orange-red, euhedral to corroded anhedral crystals and aggregates of crystals, some of which exceed several millimetres in maximum dimension. Crystals are generally prismatic, elongated along c , showing prominent development of forms $\{110\}$, $\{010\}$, $\{021\}$ and $\{\bar{1}11\}$. Locally, the durangite is partially or completely altered to yellow-green beudantite. Chemical analysis of the Black Range durangite yields $(\text{Na}_{0.93}\text{Li}_{0.07})\Sigma_{1.00}(\text{Al}_{1.00}\text{Fe}_{0.07}\text{Mn}_{0.06})\Sigma_{1.02}\text{As}_{0.99}\text{O}_4[\text{F}_{0.90}(\text{OH})_{0.07}]\Sigma_{0.97}$. Least-squares refinement of X-ray powder-diffraction data gave the following parameters for durangite from the Black Range: a 6.574(1), b 8.505(2), c 7.019(1) Å, β 115.34°, V 354.71(8) Å³. For Coneto, these were a 6.579(1), b 8.523(1), c 7.046(1) Å, β 115.47°, V 356.67(6) Å³, $Z = 4$. Space group $C2/c$. D_{obs} Coneto 3.92, D_{obs} Black Range 3.90, and D_{calc} Black Range 3.92 g/cm³. Durangite is not magnetic, does not fluoresce, has a Mohs hardness of 5 to 5.5, and has a pale yellow streak. Durangite melts congruently at $775^\circ \pm 25^\circ\text{C}$ and shows no other structural modifications.

Keywords: durangite, rhyolite, sodium-aluminum fluoroarsenate, Black Range, New Mexico.

SOMMAIRE

On a trouvé la durangite $\text{NaAl}(\text{AsO}_4)\text{F}$ en deux endroits de la chaîne Black, comté de Sierra (Nouveau-Mexique); on la connaissait en seulement trois autres localités (confirmée dans deux de celles-ci). Elle est associée à: hématite, cassitérite, \pm clinopyroxène, cristobalite, tridymite, quartz, fluorine, \pm beudantite, montmorillonite et todorokite dans des coulées et des ignimbrites rhyolitiques. La durangite, transparente à semi-opaque, de jaune pâle au rouge orangé, forme des cristaux idiomorphes ou sans faces (corrodés) ou des agrégats qui atteignent plusieurs millimètres de diamètre. Ces cristaux, prismatiques en général, allongés suivant c , montrent les formes $\{110\}$, $\{010\}$, $\{021\}$ et $\{\bar{1}11\}$. Ils s'altèrent en beudantite jaune-vert. L'analyse chimique d'un échantillon de la chaîne Black donne $(\text{Na}_{0.93}\text{Li}_{0.07})\Sigma_{1.00}(\text{Al}_{1.00}\text{Fe}_{0.07}\text{Mn}_{0.06})\Sigma_{1.02}\text{As}_{0.99}\text{O}_4[\text{F}_{0.90}(\text{OH})_{0.07}]\Sigma_{0.97}$. L'affinement par moindres carrés des

données de diffraction X (méthode des poudres) a mené aux paramètres suivants pour deux localités: a 6.574(1), b 8.505(2), c 7.019(1) Å, β 115.34°, V 354.71(8) Å³ (Black); et a 6.579(1), b 8.523(1), c 7.046(1) Å, β 115.47°, V 356.67(6) Å³ (Coneto); $Z = 4$. Groupe spatial $C2/c$. D_{obs} 3.92 (Coneto), 3.90 (Black); D_{mes} 3.92 (Black). La durangite n'est ni magnétique, ni fluorescente; elle possède une dureté (Mohs) de 5 à 5.5 et une rayure jaune pâle. Elle fond de façon congruente à $775^\circ \pm 25^\circ\text{C}$, et ne montre aucune autre forme polymorphe à température élevée.

(Traduit par la Rédaction)

Mots-clés: durangite, rhyolite, fluoroarsénate de sodium et d'aluminium, chaîne de Black (Nouveau-Mexique).

INTRODUCTION

Durangite, ideally $\text{NaAl}(\text{AsO}_4)\text{F}$, was recently discovered at two locations in the northern Black Range of southwestern New Mexico. It occurs in veins cutting alkali rhyolite host rocks and is associated with cassiterite, hematite and other minerals. One vein is approximately 1 km south-southeast of Boiler Peak, Sierra County, in a tin mine, and the other is in Seventyfour Draw, about 8 km southeast of Boiler Peak, Sierra County, at a tin prospect. Both are on land currently owned by Robert C. Kerr of Hillsboro, N.M.

Durangite was first described by Brush (1869) from tin placers in the state of Durango, Mexico. Hanks (1876) described the modes of occurrence, and crystallographic and optical data were presented by Des Cloizeaux in 1875. Additional mineralogical and chemical data on associated minerals were given by Genth (1887). The mineral was subsequently reported by Johnston (1908) and Faribault (1908) from a pegmatite dyke in granite, near New Ross, Lunenburg County, Nova Scotia. The geology and economic geology of this area were described by Goudge & Slater (1966), Mulligan (1974) and Smith & Turek (1976). Re-examination of specimens from this locality failed to reveal any durangite (Traill 1970). Results of X-ray-diffraction studies and details of the crystal structure of durangite were presented by Kokkoros (1938). Synthetic durangite was prepared and studied by Machatschki (1941). The geology and economic geology of the tin-bearing areas in Duran-

go, Mexico, have been summarized by Foshag & Fries (1942) and Smith *et al.* (1950); these bulletins describe the mode of occurrence of durangite. Fabregat (1966) presented new chemical and X-ray data for durangite as well as a complete summary of previous information on the mineral. Infrared-spectroscopic data were given for Durango durangite by Sumin de Portilla (1974). A third locality for durangite, a joint face in granite from Cheesewring quarry, Linkinhorne, Cornwall, England, was reported by Embrey (1978). The Black Range marks the fourth reported occurrence.

OCCURRENCE

In the Black Range locations, durangite occurs as small grains and aggregates in veins and veinlets several centimetres in width within zones of sericitic and argillic alteration in an alkali rhyolite host-rock of Oligocene to Miocene age. The veins form reticulate networks 3 to 100 metres wide on the periphery of rhyolite flow - dome complexes and in flows, flow breccias, welded and unwelded ash-flow tuffs and lithic tuffs.

The minerals in these veins include, in generalized paragenetic sequence, hematite (much of it specularite); cassiterite; wood tin; sanidine; cassiterite, wood tin, durangite, hematite, and silica polymorphs (quartz, tridymite, cristobalite); durangite, beudantite; fluorite, cristobalite; pink to white dioctahedral smectite, todorokite, and disordered, red-brown dioctahedral smectite. A red-brown to orange-red Ca-Fe clinopyroxene was found associated with the durangite at Seventyfour Draw but was not found at Boiler Peak.

At Boiler Peak, durangite occurs as pale yellow to medium reddish orange grains and aggregates. The grains are as much as 0.5 mm across, and the aggregates, as much as 2 mm across. The bulk of the durangite occurs as etched and altered material within the mineralized veinlets. The veinlets are irregular, pinching and swelling along strike; in places they are several centimetres or more in width. Argillic and sericitic alteration envelopes line the veinlets. Some grains, particularly those enclosed in altered rhyolite immediately adjacent to veins and veinlets of hematite, cassiterite, and silica polymorphs, are very clear, unfractured and unaltered. Durangite has been found in one shallow pit and in several other excavations made along the predominant trend of the vein system. Deposition of the durangite was contemporaneous with deposition of crystalline cassiterite and wood tin, hematite, and the silica polymorphs. The durangite encloses and is enclosed by these minerals. Extremely fine-grained white fluorite, admixed in varying proportions with cristobalite and dioctahedral montmorillonite, was subsequently deposited. Yellow-

green, fine-grained beudantite (*REE*-bearing) was deposited still later; some of the beudantite apparently crystallized along with the durangite, and some is pseudomorphic after it. The final products of deposition within the open spaces of the veins are black, sooty, fine-grained plumbian todorokite and sticky, deep red-brown, disordered dioctahedral smectite containing fragments of the previously mentioned minerals.

At Seventyfour Draw, the durangite is generally pale to medium yellow-orange or orange rather than orange-red. Individual grains are 0.5 mm across or more. The associated minerals are the same as described for Boiler Peak except that the white, fine-grained mixture of fluorite, montmorillonite and cristobalite is less abundant here. Fluorite also occurs locally as clear, grey, discrete botryoidal masses. Much of the final generation of cassiterite is in the form of rounded clumps of slender, almost white, acicular needles. Some of these clumps are several millimetres across; individual needles of cassiterite are as much as 200 μm long but only 10 μm or so wide. Euhedral, prismatic crystals and some euhedral, squat, tabular crystals of red-brown to orange-red or orange clinopyroxene (very much resembling the durangite), some of which exceed 2 mm in width, are intermixed with the cassiterite - fluorite - hematite - durangite association.

In the state of Durango, Mexico, near Coneto (Hanks 1876, Foshag & Fries 1942, Fabregat 1966), durangite occurs in tin-bearing veins associated with cassiterite, hematite (including the variety specularite), quartz, tridymite, cristobalite, opal, chalcedony, fluorite, topaz, mimetite (Genth 1887), sanidine, montmorillonite and zeolites. It has also been reported in residual and alluvial placer deposits derived from the tin veins.

The only major difference between the Black Range and Coneto assemblages is the presence of beudantite $\text{PbFe}^{3+}_3(\text{AsO}_4)(\text{SO}_4)(\text{OH})_6$ in the Black Range as an alteration product and coexisting mineral with durangite, rather than mimetite $\text{Pb}_5(\text{AsO}_4)_3\text{Cl}$, which is found associated with the durangite at Coneto.

PHYSICAL PROPERTIES

Durangite from the Black Range is pale yellow-orange to medium orange-red and is clear to semi-translucent when fresh. Individual crystals attain 1 to 2 mm in maximum dimension, but most are less than 0.5 mm across. Many of the crystals show evidence of solution etching and chemical corrosion (Fig. 1).

Density determinations for durangite from both Coneto and Boiler Peak yielded D_{obs} (Coneto) 3.92(2) and D_{obs} (Boiler Peak) 3.90(2). A density determination for durangite from Cheesewring

quarry, Cornwall (BM no. 1965, 99) gave D_{obs} 3.93. Determinations were made on a Berman microbalance with toluene as the immersion medium on samples weighing about 10 mg each. The D_{calc} (Boiler Peak) is equal to 3.92, which agrees well with the observed density.

Durangite from all localities has a vitreous luster, a pale yellow streak and a Mohs hardness of 5 to 5.5, and shows irregular and conchoidal fracture and one good cleavage $\{110\}$. It is not magnetic, does not fluoresce under either short- or long-wave ultraviolet light, and is insoluble in aqua regia, slowly soluble in either HCl or HNO₃ separately, and readily soluble in hot, concentrated H₂SO₄. The mineral melts congruently to a glass at $775^{\circ}\text{C} \pm 25^{\circ}$ in air and shows no other structural modifications.

CRYSTALLOGRAPHY

Durangite is monoclinic, prismatic, class $2/m$; the majority of euhedral crystals from the Black Range show dominant development of prism and pinacoid forms. Figure 1 is a SEM photo of a doubly terminated crystal of Black Range durangite elongate on c , and showing development of the clinopinacoid $\{010\}$ and the $\{110\}$ and $\{021\}$ prism forms. In some crystals, the prism $\{\bar{1}11\}$ is well developed. A few crystals, very much resembling gypsum, are flattened parallel to b and show development of only three forms: $\{010\}$, $\{\bar{1}11\}$ and $\{110\}$. Crystals with this habit are unetched, very pale yellow, and distinct from the predominant orange to orange-red crystals.

Crystals that resemble those synthesized by Machatschki (1941), tablets flattened on $\{102\}$ with development of the simple prism form $\{110\}$ and clinopinacoid $\{010\}$, are very rarely noted. Crystals with a bipyramidal habit, such as those from Coneto, are also very scarce.

OPTICAL PROPERTIES

Irregular compositional zonation involving substitution of Fe and Mn for Al and substitution of Li for Na produces noticeable variation in the optical properties from grain fragment to grain fragment. The means of each of the principal indices of refraction for durangite from near Boiler Peak (using Na light) are n_x 1.634(3), n_y 1.663(3), n_z 1.685(3), $n_z - n_x = 0.051$. The mineral is biaxial, optically negative, and has weak to moderate dispersion, $r < v$. The $2V_x$ ranges from about 70° to 85° ; $2V_x$ calculated from the indices quoted above is 81° . Crystals are moderately pleochroic: X medium yellow orange, Y pale yellow orange, Z nearly colorless; $Z = b$; the mineral shows distinct horizontal dispersion. One very pale yellow crystal that measures $0.43 \times 0.34 \times 0.26$ mm and shows the forms $\{010\}$, $\{\bar{1}11\}$ and $\{110\}$ has the following optical properties: n_x

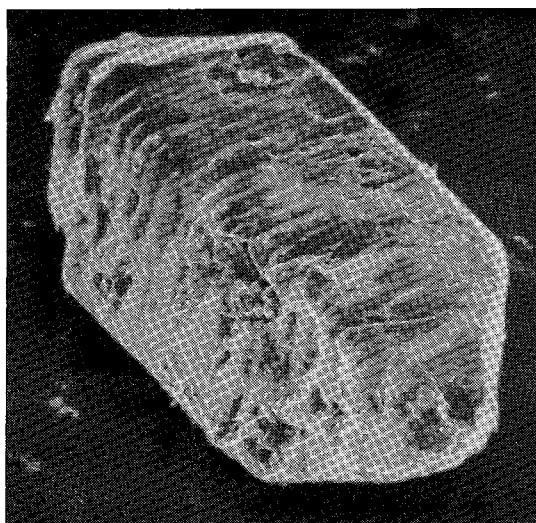


FIG. 1. Doubly terminated, etched, euhedral crystal of durangite from Boiler Peak showing development of pinacoid and prism forms $\{021\}$, $\{010\}$, $\{110\}$ and $\{\bar{1}11\}$. Width of field of view: 500 micrometres.

1.597(2), n_y 1.636(2), n_z 1.647, $n_z - n_x = 0.050$, $2V_x$ (measured on a spindle stage) $68(1)^{\circ}$, $2V_x$ (calc.) 55° ; $Z = b$, $Y = a^*$, $X\Delta c = -3^{\circ}$; X pale yellow, Y very pale yellow, Z colorless; $X > Y > Z$. Dispersion is distinct, $r < v$. Crystals of this type contain less than 1% combined Fe₂O₃ + Mn₂O₃ and approach pure NaAl(AsO₄)F.

Calculation of the compatibility of our optical, chemical and specific gravity data, using the Gladstone-Dale relationship (Mandarino 1979), yields $K_p = 0.168$ and $K_c = 0.174$, and a compatibility index of 0.034 ("excellent" on Mandarino's scale). The values are in agreement with those calculated by J.A. Mandarino (pers. comm., 1984).

X-RAY-DIFFRACTION DATA

X-ray powder-diffraction data for natural durangite are scarce in the literature (Fabregat 1966, Sabina & Traill 1960), and such data do not yet exist in the JCPDS card file. Card PDF 25-770 presents data taken from rotation photographs from material synthesized from arsenious acid and cryolite at 200°C for 36 hours (Machatschki 1941). The given d values and indexing do not agree with the powder-diffraction data available for natural material. The powder data given by Fabregat (1966) for Coneto durangite agree fairly well with data obtained by us for Coneto, Boiler Peak and Cornwall durangite. The indexing assigned by Fabregat is not correct, however, due to erroneous unit-cell dimensions derived from single-crystal precession photographs.

Such photographs taken of Boiler Peak durangite confirm the symmetry, $C2/c$, and cell dimensions given below. Indexed X-ray powder-diffraction data presented in Table 1 supersede all previously published information.

Least-squares refinement (using an updated version of the computer program written by Appleman & Evans 1973) of X-ray powder-diffraction data (44

TABLE 1. X-RAY-DIFFRACTION DATA FOR DURANGITE FROM CONETO, DURANGO, MEXICO, AND BOILER PEAK, SIERRA CO., NEW MEXICO

hkl	Coneto			Boiler Peak		
	d_{obs}	d_{calc}	I/I_0	d_{obs}	d_{calc}	I/I_0
111	4.76	4.76	80	4.75	4.75	55
020	4.26	4.26	4	4.26	4.25	5
021	3.54	3.54	40	3.53	3.53	27
111	3.34	3.34	50	3.35	3.34	50
112	3.236	3.237	80	3.227	3.225	67
200	2.967	2.970	100	2.972	2.971	100
202	2.870	2.873	30	2.864	2.865	25
221	2.601	2.603	25	2.595	2.599	25
130	2.560	2.563	60	2.556	2.559	55
022	2.549	2.549	57	2.543	2.543	45
220	2.436	2.436	17	2.432	2.435	13
222	2.382	2.382	6	2.375	2.376	6
112	2.316	2.316	3	2.312	2.313	1
131	2.236	2.238	27	2.235	2.234	35
132	2.204	2.206	17	2.200	2.199	25
040	2.130	2.130	1	2.127	2.126	1
312	2.081	2.080	15	2.076	2.077	12
223	1.984	1.983	16	1.975	1.976	14
023	1.899	1.898	3	1.892	1.893	4
313	1.869	1.868	4	1.860	1.863	4
132	1.835	1.836	8	1.832	1.833	9
202	1.816	1.816	10	1.813	1.815	12
241	1.788	1.788	4	1.786	1.785	3
042	1.770	1.770	4	1.765	1.766	4
204	1.750	1.750	20	1.742	1.743	15
331	1.727	1.727	7	1.726	1.725	3
332, 242	1.712	1.711	16	1.709	1.709	11
242				1.707	1.707	4
222	1.671	1.670	18	1.669	1.669	17
311	1.662	1.662	13	1.663	1.663	12
330	1.625	1.624	30	1.623	1.624	24
004	1.590	1.590	4	1.586	1.586	5
333	1.588	1.588	4	1.584	1.584	5
241	1.574	1.574	2	1.571	1.572	3
243	1.543	1.544	4	1.539	1.540	4
422	1.533	1.533	41	1.532	1.532	22
043, 133, 421	1.503	1.503	16	1.500	1.500	7
024	1.489	1.490	30	1.485	1.486	10
134	1.480	1.480	31	1.476	1.475	18
331	1.456	1.456	2	1.455	1.455	2
404	1.436	1.436	20	1.433	1.432	8
060	1.421	1.421	3	1.419	1.418	3
334	1.413	1.412	15			
334, 312				1.408	1.408	13
152	1.391	1.392	7	1.389	1.388	10
153, 223	1.378	1.378	3			
223				1.376	1.376	2
315	1.355	1.354	4	1.349	1.349	3
225	1.339	1.338	10	1.333	1.333	10
261	1.304	1.304	4			
442	1.301	1.301	5			
261, 442				1.301	1.301	3
260, 441	1.282	1.281	6			
441				1.283	1.282	8
260				1.280	1.279	6
421	1.265	1.266	3	1.266	1.266	4

$\text{CuK}\alpha_1$ (1.54059 Å) radiation, graphite monochromatized. Annealed CaF_2 used as an internal standard. Scan speed $1/2^\circ$ per min. Chart speed $1''$ per min.

reflections used) for Coneto durangite (USNM #81712) yielded these values (in the Des Cloizeaux-Dana-Kokkoros setting): a 6.579(1), b 8.523(1), c 7.046(1) Å, β 115.47°, V 356.67(6) Å³. Axial elements for this material are: 0.7719:1:0.8267. A similar refinement (48 reflections used) for durangite from Boiler Peak gave a 6.574(1), b 8.505(2), c 7.019(1) Å, β 115.34°, V 354.71(8) Å³; Z = 4, and axial elements are 0.7730:1:0.8253. Refined data for pure $\text{NaAl}(\text{AsO}_4)\text{F}$ do not exist, but the effect of the substitution of iron and manganese (as much as 15 atomic % or more) for aluminum should produce increased cell-dimensions and volumes such as those observed in the Coneto and Black Range durangite. Natural material from Durango examined by Kokkoros (1938) gave a 6.53(1), b 8.46(1), c 7.00(2) Å, β 115.13°, V 349.85 Å³.

CHEMISTRY

Durangite from Boiler Peak, Coneto and Cornwall was analyzed by a combination of methods including six-step emission spectrography, electron microprobe, induction-coupled plasma analysis, ion chromatography, specific-ion electrode and microcoulometric moisture analysis. A composite of the data for bulk material from Boiler Peak is given in Table 2.

TABLE 2. COMPOSITE CHEMICAL COMPOSITION OF DURANGITE FROM NEAR BOILER PEAK, SIERRA CO., NEW MEXICO

Oxide	Uncorrected	Corrected for admixed SiO_2
As_2O_5 wt. %	52.3	54.0
Al_2O_3	20.8	21.5
Na_2O	13.3	13.7
Li_2O	0.45	0.46
Fe_2O_3	2.74	2.83
Mn_2O_3	2.30	2.38
CaO	0.11	0.11
PbO	0.1	0.1
SiO_2	3.21	—
ZnO	0.17	0.18
TiO_2	0.15	0.15
H_2O^- (105°C)	0.05	0.05
H_2O^+ (900°C)	0.29	0.30
F_2	7.9 (7.7 by ion chromat.)	8.16
Cl_2	<0.2	<0.2
Total	103.87	103.92
O = F	3.33	3.44
Total	100.54	100.48

Notes - As_2O_5 , Al_2O_3 , Na_2O , Fe_2O_3 , Mn_2O_3 and ZnO determined by induction-coupled plasma analysis on 9.05 mg by J. E. Taggart, Jr. Li_2O , PbO , SiO_2 and TiO_2 determined by emission spectrography (N. M. Conklin, analyst). Waters (50 mg) determined by Karl Fischer; microcoulometric moisture analysis by H. Neimann; F determined by specific ion electrode on 20 mg by H. Neimann. Cl and F determined by Stephen Wilson and Carol Gent by ion chromatography. CaO determined by electron probe by E. E. Ford. The absence of SiO_2 was confirmed by electron microprobe, and the bulk analysis has been recalculated deducting the SiO_2 .

TABLE 3. Fe₂O₃ AND Mn₂O₃ CONTENTS IN DURANGITE

	Boiler Peak		Coneto	
	Range	Av.	Range	Av.
Fe ₂ O ₃ wt. %	1.88-4.50	3.56	2.13-5.72	3.27
Mn ₂ O ₃	1.52-4.41	2.47	1.37-4.92	2.87
Sum	—	6.03	—	6.14

Averages calculated from five determinations for each sample.

Electron-microprobe analyses showed no Si, Cl, Mg, or K to be present. Variation in sodium content was noted and is most likely due to a combination of selective Na loss during analysis and substitution of Li for Na. A similar variation noted for Al is due to the coupled substitution of Fe and Mn for the aluminum. The average Fe₂O₃ and Mn₂O₃ contents in Boiler Peak durangite are very similar to those for the Coneto material (Table 3). Also, the averages shown in Table 3 for Coneto compare favorably with results given in the literature for Coneto durangite.

An average of about 0.1 wt. % CaO was found in the Boiler Peak material (electron probe) *versus*

about 0.25% for durangite from Coneto. Lighter-colored durangite contains less Fe and Mn than darker-colored material.

A structural formula for Boiler Peak durangite was calculated from the composition (corrected for admixed silica) given in Table 2: (Na_{0.93}Li_{0.07})_{Σ1.00}(Al_{0.89}Fe_{0.07}Mn_{0.06})_{Σ1.02}As_{0.99}O₄(F_{0.90}(OH)_{0.07})_{Σ0.97}. Minor but definite substitution of hydroxyl for fluorine is present. Fabregat (1966) found no water of crystallization in durangite from Coneto.

Emission-spectrographic semiquantitative analyses were made for durangite from Boiler Peak, Coneto and Cornwall (Table 4). The concentrate is material free of any visible contaminants and nearly of gem quality.

Elements detected in anomalous amounts in the Boiler Peak durangite include Cu, Nb, Pb, Sn, Y, Zn, Zr, Ga and In (Table 4). The Coneto durangite shows anomalous concentrations of the same elements, except for Pb, and also has an anomalous Sb content. Durangite from Cornwall is very similar to that from the other two localities but contains somewhat more Nb (100 ppm) and no Y or Yb.

CONCLUSIONS

The durangite in the Black Range is thought to have been deposited in the late stages of a system that ranged from a high-temperature episode of magmatic vapor-phase deposition to a low-temperature episode of hydrothermal activity. Hematite and cassiterite were apparently deposited in fractures and open spaces at near-magmatic temperatures; with progressive cooling, cassiterite replaced some of the hematite, probably under alternating boiling and liquid hydrothermal conditions. The durangite, along with more wood tin, silica polymorphs, beudantite, fluorite and other minerals, was subsequently deposited in a liquid-dominated hydrothermal system. Fluid-inclusion homogenization temperatures of about 400°C and less have been reported for macrocrystalline cassiterite from a number of vein systems in the Black Range (D. Harvey, University of Texas, El Paso, written comm., 1984).

Durangite and beudantite are the only two arsenic-bearing minerals that have been found to date in the Black Range tin deposits, and durangite and mimitite are the only two found at Coneto. Sulfur-bearing minerals have not been reported from Coneto, but such minerals (beudantite and alunite) do occur in the Black Range.

To date, durangite has been found in moderate abundance, locally, in two very similar rhyolite provinces (Durango, Mexico, and Black Range, New Mexico) and in two "tin granites" (Nova Scotia and Cornwall), associated in every case with tin mineralization. Durangite may be a mineral commonly associated with cassiterite. Hence, it should exist at

TABLE 4. SEMIQUANTITATIVE SIX-STEP EMISSION SPECTROGRAPHIC ANALYSES FOR DURANGITE FROM BOILER PEAK, SIERRA CO., N.M.; CONETO, DURANGO, MEXICO; AND CHEESEWRING QUARRY, LINKINHORNE, CORNWALL

Element	Boiler Peak	Coneto	Cornwall
Data in percent			
Fe	1.5	3.0	7
Mg	0.05	0.007	0.007
Ca	0.3	0.03	0.01
Ti	0.15	0.002	0.02
Al	Major	Major	Major
Na	Major	Major	Major
K	N	N	N
Mn	1.5	0.3	1.0
Data in parts per million			
As	Major	Major	Major
Ba	15	15	20
Bi	N	L	N
Cr	3	1.5	5
Cu	30	50	50
Nb	30	50	100
Ni	7	N	10
Pb	1000	N	N
Sb	N	700	500
Sn	700	1500	1000
Sr	15	N	N
V	L	N	N
Y	30	100	N
Zn	1000	1500	1000
Zr	150	70	100
Ga	30	70	100
In	70	300	200
Lt	1500	2000	1500
Yb	7	7	N

Analyst: Nancy M. Conklin. Elements looked for but not detected at respective limits of detection were K, Be, La, Sc, Ca, Ag, Au, B, Cd, Co, Mo, Pd, Pt, Te, U, W, P, Ge, Hf, Re, Ta, Th, Tl. Durangite sample from Cornwall weighed only 3.8 mg and was diluted with carbon powder and factored accordingly. N, not detected. L, detected in amount less than the lower limit of detection.

other tin deposits in the world and has probably been overlooked at a number of these (e.g., Bolivia, Malaysia, USSR) because identification based on powder X-ray-diffraction data cannot be made at present using the powder-diffraction file.

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