Canadian Mineralogist
Vol. 27, pp. 419-426 (1989)

CHROMIAN DRAVITE ASSOCIATED WITH ULTRAMAFIC-ROCK-HOSTED ARCHEAN LODE GOLD DEPOSITS, TIMMINS–PORCUPINE DISTRICT, ONTARIO

ROBERT W. KING AND ROBERT KERRICH
Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan S7N 0W0

ABSTRACT

In most instances, tourmaline associated with Canadian Archean lode gold deposits belongs to the schorl–dravite solid-solution series; Fe-rich compositions tend to predominate. However, at the Beaumont property and the Buffalo Ankerite mine in the Timmins–Porcupine district, Ontario, tourmaline is found whose elevated Cr and Mg contents warrant classification as chromian dravite (0.42–1.52 wt.% Cr_2O_3, 8.08–8.74 wt.% MgO). These tourmaline compositions show Mg > Fe > Cr and Na > Ca. Relatively high Al contents (> 6 atoms per formula unit) suggest Cr substitution for Mg in the *Y* site rather than for Al in the *Z* site. Both occurrences are spatially associated with serpentinized peridotite bodies and komatiitic flows.

Keywords: tourmaline, chromium, dravite, schorl, gold deposit, Abitibi greenstone belt, komatiite, tholeiite, peridotite, Ontario.

SOMMAIRE

Dans la plupart des cas, la tourmaline associée aux gisements d'or en "veines" d'âge archéen au Canada fait partie de la solution solide schorl - dravite. Sa composition tend à être riche en fer. Toutefois, dans le cas de l'indice de Beaumont, aussi bien qu'à la mine de Buffalo Ankerite, dans le camp minier de Timmins–Porcupine, en Ontario, la tourmaline possède une teneur élevée en Mg et Cr (0.42–1.52% de Cr_2O_3, 8.08–8.74% de MgO par poids) et justifie le terme *dravite chromifère*. Les compositions montrent Mg > Fe > Cr et Na > Ca. Une teneur relativement élevée en aluminium (plus de 6 atomes par unité formulaire) fait penser que le Cr remplace le Mg dans la position *Y* plutôt que l'aluminium dans la position *Z*. Les deux exemples sont associés dans l'espace avec un massif de péridotite serpentinisé et des coulées de komatiite.

(Traduit par la Rédaction)

Mots-clés: tourmaline, chrome, dravite, schorl, gisement d'or, ceinture de roches vertes de l'Abitibi, komatiite, tholéite, péridotite, Ontario.

INTRODUCTION

Tourmaline is one of the characteristic gangue minerals in lode gold deposits of the Archean Superior Province (Bain 1933, Boyle 1979). The tourmaline mostly belongs to the schorl–dravite series, with Fe-rich compositions predominating (King & Kerrich 1986, King *et al.* 1986, 1988, King 1988). Two occurrences of Cr-rich dravite have been identified in the course of a systematic study of the chemical and isotopic properties of tourmaline paragenetically associated with precious metal mineralization in the Abitibi greenstone belt. This paper describes mode of occurrence, geological setting, and microprobe compositions of chromian dravite from the Beaumont property and the Buffalo Ankerite mine, Timmins, Ontario, and compares them with tourmaline from other gold deposits in the Timmins–Porcupine district specifically, and the Abitibi greenstone belt in general.

GEOLOGICAL SETTING

Both the Beaumont property and Buffalo Ankerite mine are located within the Timmins–Porcupine gold district, which is one of the largest producing Archean lode gold areas in the world. The geology of the Timmins–Porcupine area has been reviewed by Dunbar (1948), Ferguson *et al.* (1968), Pyke (1975, 1982), Davies (1977), and Hodgson (1983). Volcanic and sedimentary rocks in the study area have been folded into a major west-plunging synform (Pyke 1982) called the Porcupine Syncline. The majority of gold deposits in the Timmins–Porcupine district are confined to Formation IV of the Upper Supergroup, close to the boundary between the two volcanic cycles (Pyke 1982). Most of the gold-bearing quartz - ferroan dolomite - tourmaline veins are located in brittle–ductile shear zones that crosscut the stratigraphy.

Geology of the Beaumont property

The Beaumont property lies at the base of the Upper Supergroup (Formation IV) on the north limb of the Porcupine Syncline. In the vicinity of the Beaumont property, Formation IV consists predominantly of basaltic and ultramafic flows. Gold mineralization is associated with quartz–carbonate veins emplaced along carbonatized zones that trend northeast, in general conformity with the strike of the volcanic stratigraphy. The veins are discontinu-

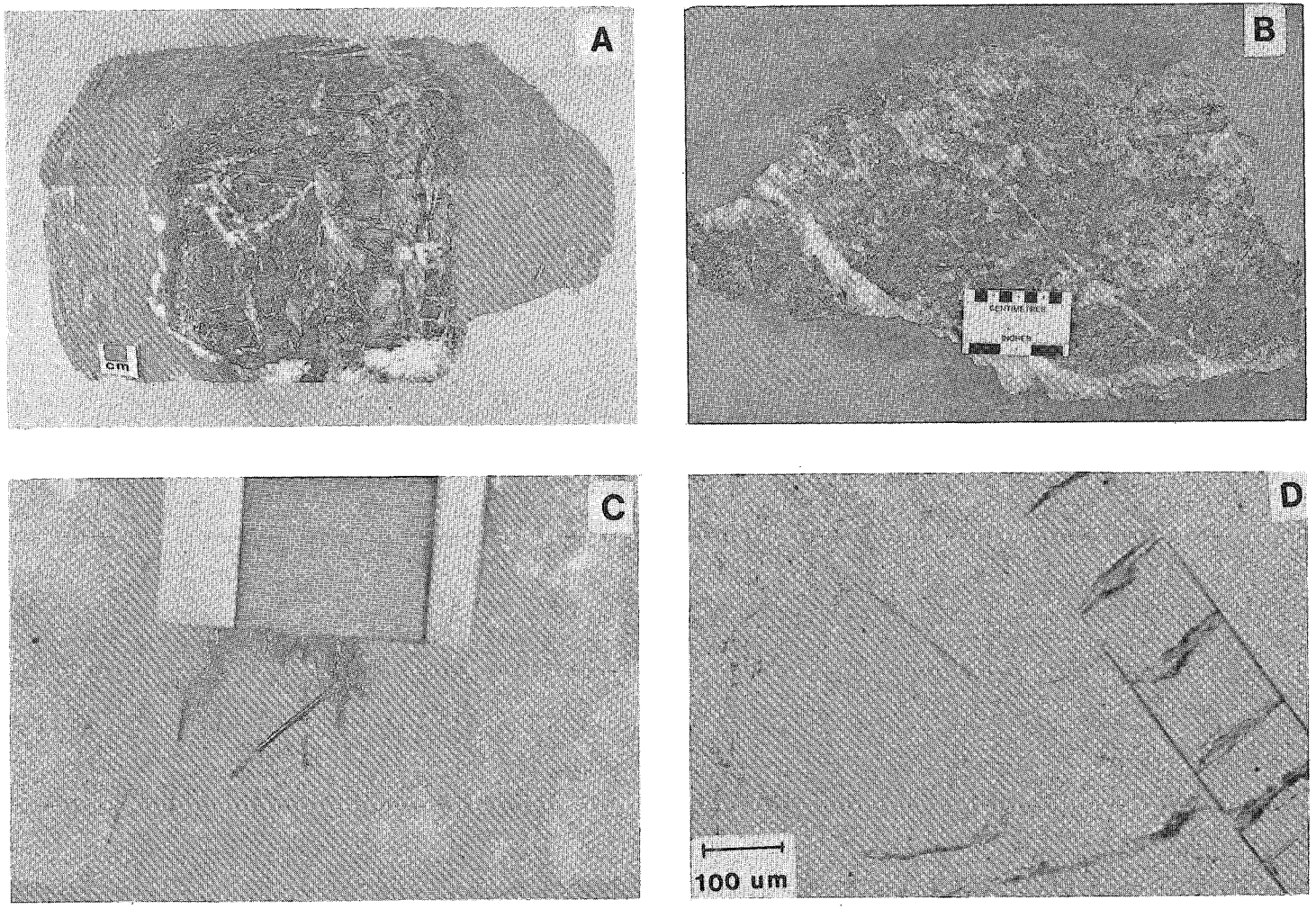

FIG. 1. A. Stratabound quartz – ferroan dolomite – tourmaline vein from the Buffalo Ankerite mine. Photograph taken on an angle to emphasize boudinaged appearance of the vein. B. Ore-bearing stockwork quartz–tourmaline vein, Buffalo Ankerite mine. C. Slender prisms of chromian dravite in quartz vein from the Beaumont property. Chromium-rich tourmaline at the Buffalo Ankerite mine occurs in the same manner (scale bar = 1 cm). D. Euhedral chromian dravite needles in a quartz vein (Beaumont property). Note the lack of optical zonation in the needles and the intense cross fracturing in longitudinal section (plane-polarized light).

ous lenses, composed mainly of quartz, many of which have flat-dipping branches (Ferguson *et al.* 1968). Pyrite and tourmaline are the only accessory minerals associated with the gold-bearing quartz veins of this deposit. No significant gold reserves have been proven despite historical underground development (1927–1928), and recent (1980s) diamond drilling.

Geology of the Buffalo Ankerite mine

Gold mineralization at the Buffalo Ankerite mine occurs at the base of the Upper Supergroup (Formation IV), on the south limb of the Porcupine Syncline. The ultramafic and Fe- and Mg-tholeiitic basalt flows exposed in the mine area are interpreted (Pyke 1982, Fyon *et al.* 1986) to be stratigraphically equivalent to flows at the Beaumont property, and to those in the area of the Pamour No.1, Bell Creek, Owl Creek, and Hoyle Pond mines on the north limb of the syncline. Basaltic and ultramafic komatiitic flows crop out at the base of the section and are overlain by Mg-rich tholeiitic basalt.

Auriferous veins in this mine differ in character from those in the remainder of the Timmins–Porcupine district in terms of the greater abundance of tourmaline (up to 65 modal %), carbonate (up to 15 modal %), and pyrite (Kinkel 1948) relative to quartz. Gold occurs predominantly as inclusions in pyrite or, less commonly, as visible gold in late-stage extensional quartz veins.

Tourmaline at the Buffalo Ankerite mine is present in three distinct generations of veins: (1) stratabound quartz – ferroan dolomite – tourmaline veins (Fig. 1A), (2) stockwork quartz–tourmaline veins (Fig. 1B), and (3) late extensional quartz veins. All three generations of tourmaline-bearing veins contain gold, but only the stockwork quartz–tourmaline veins were mined as gold ore. The tourmaline in both the stratabound and stockwork veins occurs as ultrafine-grained ($\leq 200\ \mu m$), dark brown to black aggregates, layered to somewhat massive in configuration.

The third generation of tourmaline in the Buffalo Ankerite mine is a distinctive emerald green variety that occurs in zones of quartz flooding within the carbonatized ultramafic flow unit, which forms the stratigraphic footwall to the main mineralized zone. These veins, which grade <3 g/t Au (Fyon *et al.* 1986), consist largely of milky white quartz with minor amounts of acicular tourmaline and visible gold (Fig. 1C).

The Beaumont and Buffalo Ankerite study areas are characterized by their common stratigraphic position within a sequence of ultramafic to mafic volcanic flows. There is a significant difference, however, in that felsic rocks and chemical and volcaniclastic sediments only occur in the latter area.

Physical and Optical Characteristics of the Tourmaline

Chromium-rich tourmaline at both the Beaumont property and the Buffalo Ankerite mine is characterized in hand specimen by distinctive emerald green coloration. At both localities the tourmaline forms long, slender, hexagonal, prismatic, translucent crystals up to 3 cm long, with good rhombohedral terminations (Fig. 1C). Like most members of the tourmaline group except buergerite (Dietrich 1985), the chromium-rich tourmaline shows no cleavage. In thin section, the euhedral acicular tourmaline is colorless to pale green, and lacks optical zonation (Fig. 1D). This absence of optical zonation is a characteristic feature of tourmaline associated with gold deposits of the Superior Province, and contrasts with the strongly zoned tourmaline typical of pegmatites and massive sulfide deposits (Manning 1982, Taylor & Slack 1984).

In longitudinal section, the tourmaline needles show variable intensities of cross-fracturing, with some displacement along the fractures (Fig. 1D); however, no alteration occurs along the fractures. Microprobe traverses from core to rim and from core to fracture boundaries verify this observation (see below). In both occurrences, the chromium-rich tourmaline generally coexists with calcite and ferroan dolomite, albite, Cr-bearing muscovite, pyrite and gold.

TABLE 1. COMPOSITION OF TOURMALINE FROM THE BEAUMONT PROPERTY AND BUFFALO ANKERITE MINE

Location	Beaumont	Buffalo Ankerite		
Sample	Cr-rich dravite	Cr-rich dravite	Qtz-Ank vein	stockwork vein
SiO_2 wt.%	37.33 (0.32)	37.22 (0.20)	37.19 (0.05)	37.18 (4.89)
Al_2O_3	33.97 (0.60)	33.14 (0.32)	33.86 (1.06)	34.64 (1.69)
TiO_2	0.04 (0.00)	0.08 (0.02)	0.14 (0.04)	0.25 (0.10)
FeO*	2.67 (0.28)	3.33 (0.02)	2.77 (0.24)	4.69 (2.78)
MnO	0.02 (0.00)	0.04 (0.00)	0.02 (0.00)	0.00 (0.00)
MgO	8.59 (0.02)	8.33 (0.08)	8.21 (0.10)	6.95 (0.23)
Cr_2O_3	0.61 (0.01)	1.33 (0.02)	0.26 (0.02)	0.15 (0.02)
CaO	0.01 (0.00)	0.01 (0.00)	0.02 (0.00)	0.25 (0.27)
Na_2O	1.89 (0.25)	2.06 (0.08)	2.56 (0.08)	2.29 (0.13)
K_2O	0.02 (0.00)	0.01 (0.00)	0.00 (0.00)	0.02 (0.00)
Total	86.15	85.55	85.03	86.42
Structural formulae on the basis of 29 oxygen atoms				
B**	3.000	3.000	3.000	3.000
$^{Si}_{IV}Al$	6.000 0.000	6.000 0.000	6.000 0.000	5.956 0.044
$^{VI}Al_Z$	6.000	6.000	6.000	6.000
$^{VI}Al_Y$	0.437	0.298	0.441	0.498
Ti	0.005	0.010	0.017	0.030
Fe	0.359	0.449	0.374	0.628
Mn	0.002	0.004	0.002	0.000
Mg	2.058	2.001	1.974	1.659
Cr	0.078	0.169	0.033	0.019
Y site	2.939	2.931	2.841	2.834
Ca	0.002	0.002	0.003	0.043
Na	0.589	0.644	0.801	0.711
K	0.004	0.002	0.000	0.004
X site	0.595	0.648	0.804	0.758

Notes: * Total Fe reported as FeO; ** Boron assumed to be present in amount needed to satisfy stoichiometry. Symbols: Qtz quartz, Ank ankerite.