TAD – an unusual porphyry occurrence in the Dawson Range, Yukon

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Hart, C.J.R., 1998. Tad – an unusual porphyry occurrence in the Dawson Range, Yukon. *In:* Yukon Exploration and Geology 1997; Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p.145-151.

ABSTRACT

The Tad mineral showing is an unusual porphyry-style occurrence in west-central Yukon as it contains zinc as its primary metal. This is unlike the majority of porphyry deposits in the Dawson Range which contain copper and some combination of molybdenum and gold. The Tad occurrence is hosted in a 2 km wide plug that is composed of a crowded plagioclase-quartz-biotite porphyry. A radiometric survey over the Tad property indicates that it has a large area with a low Th/K ratio. This signature is similar to, although larger and slightly less intense than, the Casino copper-molybdenum-gold deposit. The Tad property also contains supergene oxide gold mineralization, and molybdenum mineralization is hosted in the adjacent quartz monzonite country rocks.

RÉSUMÉ

La venue minérale de Tad est atypique parmi les occurrences de type porphyrique du centre-ouest du Yukon en ce qu'elle renferme du zinc comme métal principal. La plupart des gisements porphyriques du chaînon Dawson contiennent en effet du cuivre et, en quantités moindres, du molybdène et/ou de l'or. L'occurrence de Tad est incluse dans un culot crétacé atteignant 2 km de largeur. Ce culot est composé d'un porphyre encombré à plagioclase-quartz-biotite. Un levé radiométrique du porphyre de Tad indique la présence d'une zone étendue caractérisée par un faible rapport Th/K. Cette signature est semblable à celle du gisement de cuivre-molybdène-or de Casino, mais plus étendue et légèrement moins intense. Le gisement de Tad renferme également des minéralisations aurifères d'oxydes supergènes; des minéralisations de molybdène sont incluses dans les roches encaissantes adjacentes de monzonite quartzique.

INTRODUCTION

Since the late 1960s, numerous copper-molybdenum-gold porphyry deposits and occurrences have been discovered in the Dawson Range of west-central Yukon. The majority of these occurrences have copper and some combination of molybdenum and gold as their chief commodities. Most of these deposits occur along a northwest-trending linear belt that forms the Dawson Range mineral belt (Fig. 1). The largest deposit is the Casino copper-molybdenum-gold porphyry (675 million tonnes of 0.25% Cu, 0.02% Mo, 0.48g/t Au; Yukon Minefile 115J 028).

The TAD occurrence (Yukon Minfile115I 031) is an unusual porphyry occurrence as it has zinc as its principal metal, although it has an associated molybdenum zone. In addition, this property has potential for a bulk-tonnage, low-grade oxide gold deposit. The nearby Phelps occurrence hosts copper mineralization.

Much of the Dawson Range lay beyond the limit of continental glaciation. As a result a thick regolith has developed over millions of years leaving little outcrop. To assist mineral exploration efforts approximately 9000 line-kilometres of airborne gamma-ray and magnetics survey (AGMS) was flown (Geological Survey of Canada 1994a,b, 1995a,b,c). These surveys provide a quantifiable indication of rock types and alteration and are particularly useful in unglaciated regions where the surface material (colluvium) approximates the underlying bedrock (i.e., a veneer of glacial drift is absent). These data will improve geological maps in the region (e.g., Johnston and Shives, 1995). In addition, the survey results provide useful exploration tools. The geophysical signature of the Tad property is evaluated in this paper.

LOCATION

The Tad property (62°33'35"N, 137°55'15"W) is located approximately 100 kilometres northwest of the village of Carmacks in the central Dawson Range (Fig. 1) in NTS map area 115I/12. The property is accessible by helicopter from Carmacks. The Casino Trail, a winter tote trail that passes the property, continues west from the end of the upgraded portion of the road near the Cash property. The two airstrips on the property would require upgrading before use, however, the airstrips at Minto and Revenue provide road-accessible staging areas.

GEOLOGY

The regional geology of this portion of the Dawson Range is described by Johnston and Hachey (1993). The region is dominated by metamorphic rocks of the Yukon-Tanana Terrane which are intruded by batholiths of Early Jurassic and mid-

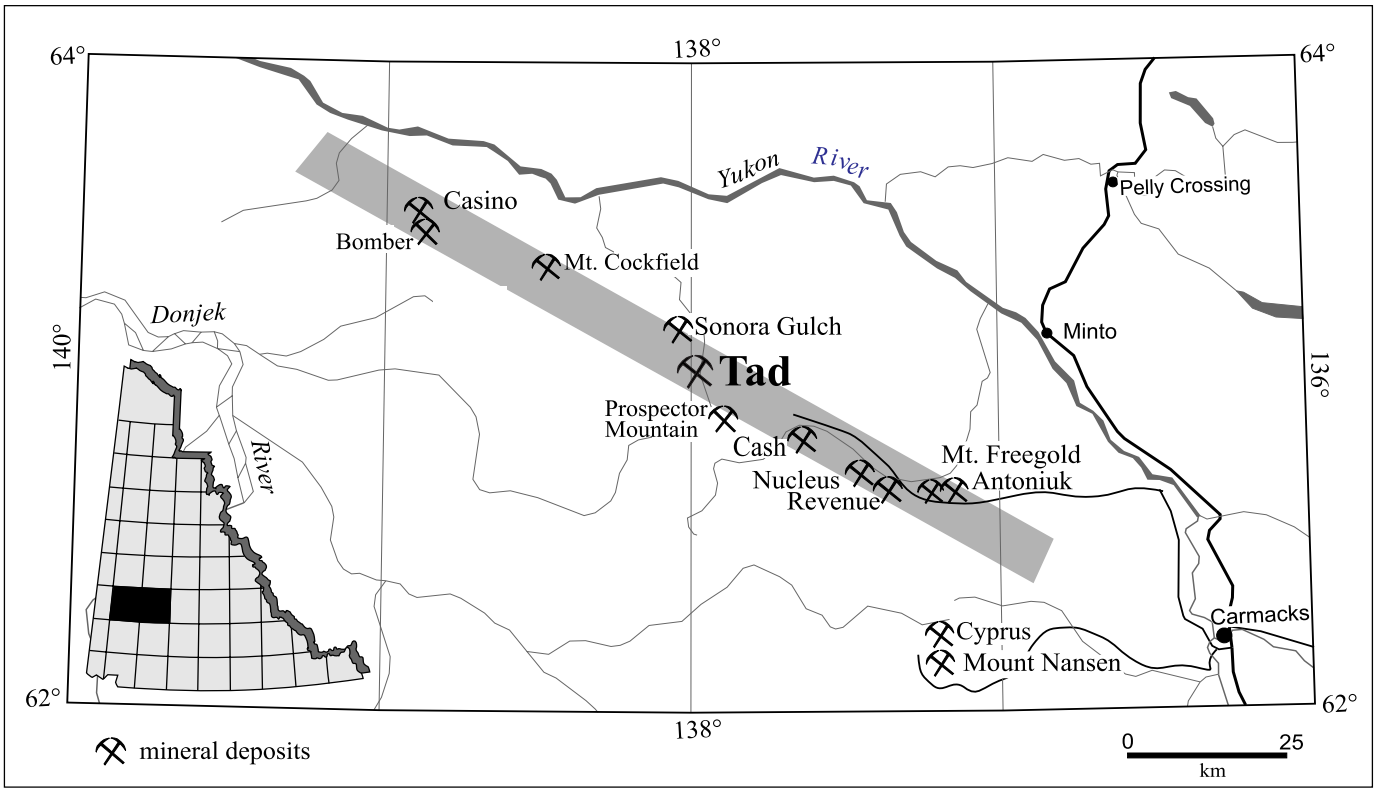

Figure 1. *Location of Tad occurrence within the Dawson Range mineral belt (shaded).*

Cretaceous age. Caulderas of mid-Cretaceous Mount Nansen Group fragmental andesite occur in the eastern part of the Range. The Late Cretaceous Carmacks Group comprise extensive sheets of shoshonitic basalt that locally occur as considerable thickness of stacked flows. Associated intrusive rocks are limited to a few small felsic plugs.

Like most of the porphyry occurrences of the Dawson Range, the Tad porphyry is located immediately southwest of the Big Creek Fault — a prominent structural feature that appears to control the distribution of mineralization in the Dawson Range. A second, north-trending fault is thought to exist beneath the Hayes Creek valley. At least four small northeast-trending faults have been recognized cutting the Tad porphyry.

The geology of the Tad area is apparently simple — although this is based upon the sparse outcrop exposure (Fig. 2). The Tad property is centered on a felsic porphyry stock which is approximately 3 by 2 km and intrudes coarse-grained, pink quartz monzonite that hosts pendants of Yukon-Tanana Terrane metamorphic rocks. The intrusive relationships were observed in drill core (DDH T-10).

The Tad porphyry is composed of a leucocratic, crowded quartz-feldspar-biotite porphyry. Quartz forms clear phenocrysts up to 8 mm in diameter that comprise approximately 20% of the rock. Feldspar forms smaller (2-6 mm), yellowish, euhedral phenocrysts which occupy up to 50% of the rock. Biotite, also euhedral, is smaller and sparser, occupying only 5%. The fine-grained light blue-grey matrix comprises approximately 25% of the rock volume. The porphyry has a granitic or quartz monzonitic composition. Most samples also contain up to 5% disseminated pyrite. Near-surface samples of the Tad porphyry are variably oxidized with limonite staining and dark brown feldspars (Fig. 3).

The quartz monzonite is composed of approximately 30% quartz and 60% alkali feldspar with variable amounts of plagioclase and up to 15% muscovite. It is possible that muscovite is a late alteration mineral as it occurs as replacements, blebs and in quartz veinlets.

The ages of the intrusive rocks are not precisely known. The quartz monzonite is thought to be a late stage intrusive phase associated with the mid-Cretaceous Dawson Range Batholith and is therefore approximately 105 Ma. The Tad porphyry may be a still later phase of the Dawson Range Batholith, or may be a Late Cretaceous (*circa* 70 Ma) intrusion associated with the Prospector Mountain Plutonic Suite (Johnston, 1995).

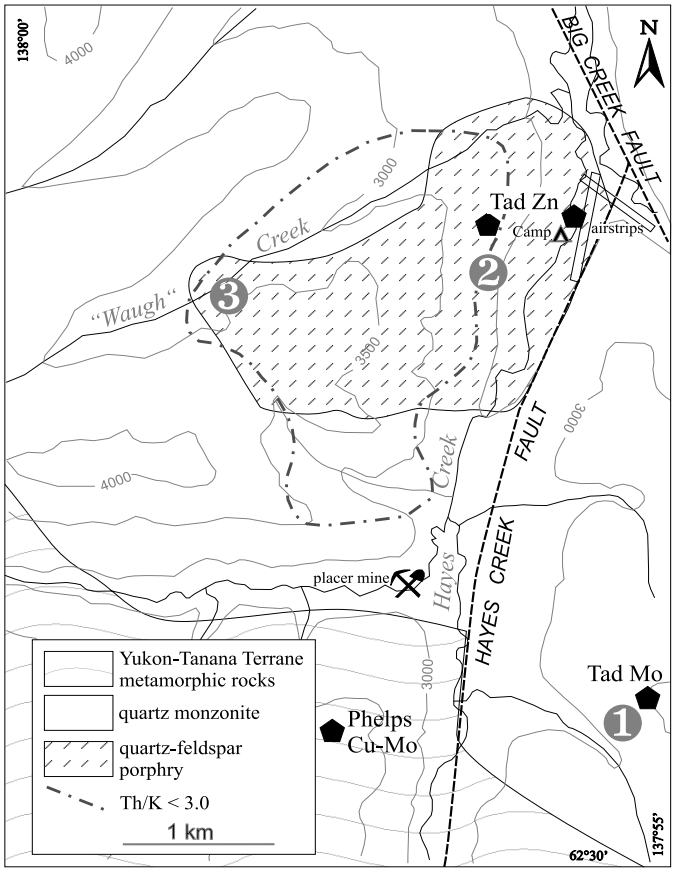

Figure 2. *General geology of the Tad occurrence. Numbers represent anomalous zones from 1970 soil sampling.*

EXPLORATION HISTORY AND RESULTS

Several old cabins built by prospectors around 1898 were noted along Hayes Creek by Bostock (1936). One of these cabins is on the Tad property, near the present site of the exploration camp. It was during this time that placer gold was likely discovered. There have been several modern-day exploration and mining efforts for placer gold in the region.

The TAD mineral occurrence was discovered in 1969 as part of a regional exploration project by International Mine Services (Waugh, 1970). Disseminated sphalerite was recognized in phyllic-altered feldspar porphyry in a gossanous outcrop

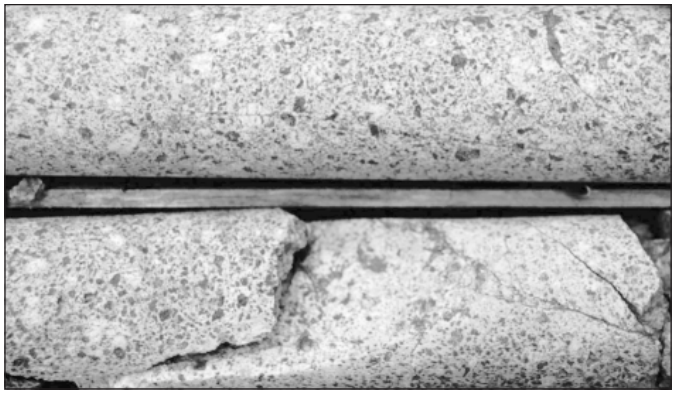

Figure 3. *Diamond drill core (NQ-size) of the Tad porphyry from the oxide zone. Light-coloured phenocrysts are quartz and alkali feldspar; dark specks are altered plagioclase.*

exposed in Hayes Creek. Subsequent soil sampling, trenching and geophysical (mag and IP) surveys were undertaken. Three geochemically anomalous zones were identified: 1) irregular molybdenum values with weak copper values extends two kilometres along a ridge east of Hayes Creek; 2) a broad 1.5 km long Zn-Pb in soil anomaly with coincident IP chargability high and magnetic highs, west of Hayes Creek; and 3) a two kilometre-long Zn-Pb soil anomaly on the southwestern side of the property near "Waugh Creek." All zones were subsequently trenched, and are hereafter referred to by the numbers above.

Mineralization in the anomalous zones was tested with a total of 2708 metres of NQ core drilled in 18 holes during the winter of 1969-70. Most of the holes were sited in the zinc zones, and were drilled to depths of 191 metres; five holes targeted the molybdenum zone and were drilled to depths of 229 metres. Molybdenum mineralization was discovered in hole T-9 in Zone 1.

The best grades from Zone 2 included a 5.6 m section of well mineralized brecciated porphyry that gave 1.83% Zn, 0.36% Cu, 0.04% Cd, 0.04 opt Au and 0.69 opt Ag (DDH T-2), and a 1.5 m wide intersection that gave 1.28% Zn, 0.06% Pb, 0.1 opt Ag (DDH T-12).

In 1986, Noranda undertook a sampling program of on-site drill core from 10 drill holes to assess the oxide gold potential of the property (Hart, 1986). One hundred and fourteen samples, representative of core lengths between 1.2 and 5.0 metres were analysed. Intervals with up to 2080 ppb Au with 7.4 g/t Ag (DDH T-14) were determined. A selected sample gave a result of 3100 ppb Au, 20 ppm Ag and 2.68% Zn over 0.5 metres. Encouraging values were found in three of the holes:

T-2 0.51 g/t Au over 37.0 m (incl. 1.0 g/t Au over 8.2 m);

T-12 1.23 g/t Au over 4.9 m

T-14 1.68 g/t Au over 7.0 m

The highest gold values were found to be coincident with rocks revealing the most intense oxidation, brecciation and alteration. They are easily recognized by abundant limonite or manganese staining. Richest gold values occur at three-quarters the depth from the surface to the base of oxide zone (typically 43-60 m); deeper oxide horizons (75 m) tend to have lower values. Gold grades beneath the base of the oxide horizon, intersected at elevations between 734 and 797 m (2422 and 2613 feet above sea level), were rarely above 100 ppb. The results are therefore considered to relate to a gold-enriched supergene oxide zone.

Samples from one hole were also analysed for base and associated metals. Gold values correlate well with arsenic; As values are 10 x Au if Au>100 ppb. Arsenic also positively correlates with silver but negatively with zinc. Background hypogene gold, silver and zinc values in the Tad porphyry are about 50 ppb, 2.0 ppm and 500 ppm, respectively.

Figure 4. *View southwesterly over the Tad property, showing the location of the gold-in-soil geochemical anomaly identified by Noranda in 1987. This anomaly likely represents the intersection of supergene gold horizon with the present erosion surface.*

These results encouraged Noranda to undertake a soil sampling program in 1986. The 150 samples that they collected yielded values up to 250 ppb Au, 12 ppm Ag and 900 ppm As in three regions. This survey was followed up in 1987 with a new grid which targeted the anomalous regions. Grid lines were ripped with a bulldozer and followed-up with 213 soil samples, and 64 rock samples. The new samples provided higher gold values (up to 815 ppb) and more complete sample coverage on permafrost-covered north slopes. Gold-in-soil anomalies formed a 950 metre long, 100 m wide, northwest-trending region that parallels a weak break-in-slope of the hill that partly overlies the original zinc anomalies of zone 2 (Fig. 4).

Noranda also undertook a short four-hole diamond drill program. Although the original intent of the program was to explore for oxide gold potential, drill holes were sited on coincident gold-in-soil and IP anomalies. As a result, the Noranda drilling intersected moderately altered, but largely unoxidized, pyritiferous rock.

The property was subsequently optioned by Nicholson and Associates who undertook extensive soil sampling and analyses in 1996.

GAMMA RAYS

Porphyry copper deposits are typically associated with a gamma-ray response of elevated K and a low Th/K ratio. This typically represents potassic alteration in the core of the porphyry system.

The Tad porphyry stock does not appear as a distinct feature on most of the AGMS maps, perhaps due to the similar chemistry of the host quartz monzonite. However the Tad porphyry is distinct on the plot of Th/K ratio, indicated by a low ratio of approximately 3.00 to 3.5 over an irregularly-shaped 2.0 x 2.2 km region (Fig. 5b). This is similar to the Casino porphyry which has values of 3.5 to 2.5 over an elliptical region of 1.7 x 1.2 km. Unlike the Casino porphyry which yields K values in the range of 3-3.5%, the Tad porphyry typically gives values of 1.4-1.6%. Actual values are probably higher (geochemical analyses are forthcoming) because the Tad porphyry is poorly exposed and largely covered by forested moss and underlain by permafrost. (In 1994 a forest fire swept through the region underlain by the Tad porphyry and resulted in the melting of the permafrost.) The Casino occurrence yields very high K values due to its position above tree line and greater rock exposure created by extensive trenching, as well as potassic alteration. Thorium values at both porphyries approximate 4.6 to 5.0 ppm.

MINERALIZATION

Mineral showings in the area include the Tad zinc-gold occurrence, the Tad molybdenum occurrence and the Phelps copper occurrence. In the Tad zinc-gold occurrence, pyrite is the most common and abundant sulphide mineral and occurs in veinlets, disseminations and fracture coatings. Sphalerite is coarse-grained (up to 3 mm), crystalline and dark brown. It occurs as disseminations in altered portions of the Tad porphyry and as part of the matrix of breccias developed within the porphyry. A petrographic report (Boorman et al., 1970) noted that marcasite and lesser amounts of pyrrhotite, chalcopyrite, galena, arsenopyrite and bournanite? are also associated with the mineralized zones. Magnetite rimmed by hematite was a common feature in the oxide zones.

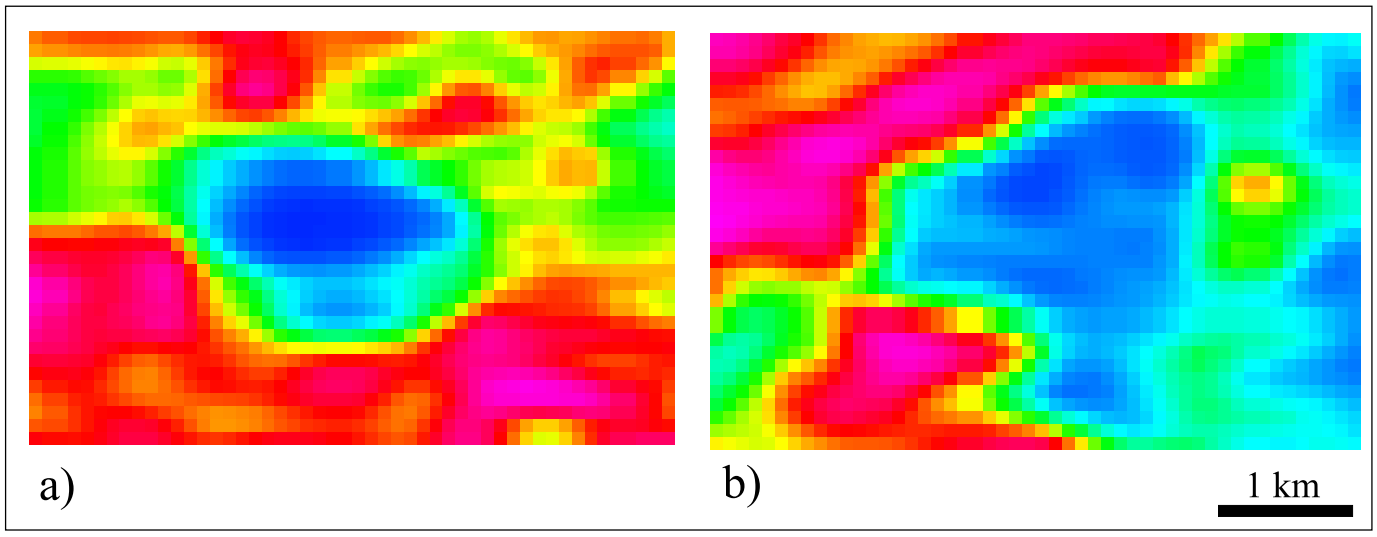

Figure 5. *Detail from the Th/K ratio geophysical survey (Geological Survey of Canada, 1994a,b), centered upon the a) Casino and b) Tad porphyry occurrences. Darker regions in the centre of the figures represent lower ratios. The Casino occurrence yields an elliptical doughnut-shaped anomaly. The Tad Zn occurrence yields a slightly irregular-shaped anomaly that coincides with the Tad porphyry (see Fig. 2).*

Tad molybdenum occurrence is hosted in quartz veins that cut the coarse-grained quartz monzonite and less often occurs as disseminations in the quartz monzonite. The quartz monzonite locally contains zones of coarse-grained muscovite. Much of the drill core from the molybdenum zone is extensively phyllic-altered, with chlorite, epidote and lesser illite on fracture surfaces. The molybdenum occurrence is not spatially, nor likely genetically related to mineralization within the Tad porphyry due largely to different host rocks and the distance between them.

The Phelps occurrence, located 5 km south of the Tad, contains bornite and chalcopyrite in quartz stringers with minor disseminated chalcopyrite.

DISCUSSION

The Tad porphyry is unique in that it has zinc as its primary ore metal and not copper. Although sphalerite was recognized as occurring in approximately 12% of Cordilleran porphyry deposits (Pilcher and McDougall, 1976), it is primarily associated with copper porphyry deposits. Sphalerite, galena and pyrrhotite all typically occur peripheral to the pyrite shell of typical porphyry copper deposits (Guilbert and Lowell, 1974; Drummond and Godwin, 1976). As such, targeting copper mineralization may be possible by recognizing a geometry of the zinc zones with respect to the IP anomalies which typically define the pyrite shell. The Tad molybdenum zone does not appear to be related to the Tad porphyry or the zinc mineralization.

Arsenic in soil anomalies are unusual in typical porphyry copper deposits. Arsenopyrite is recognized in only 3% of Cordilleran deposits (Pilcher and McDougall, 1976). However, arsenopyite and significant arsenic-in-soil anomalies have been recognized at several porphyry-style mineral occurrences in the Dawson Range (e.g., Antoniuk; Hart and Jober, 1997).

A supergene gold deposit may exist at Tad. Noranda's diamond drill holes were collared at low topographic levels where erosion had already excavated through the supergene zone and exposed the topographically lower hypogene (unoxidized) zone. Attempts to define a supergene gold zone should be initiated higher, in the oxide realm. Although the base of the oxide horizon is undulatory, it appears to approximate the 760 m (2500') contour. Previous drilling and soil sampling suggests that the base of the supergene zone is exposed at the present erosional surface at approximately 745 m (2450') elevation.

ACKNOWLEDGEMENTS

I wish to thank Charlie Roots for editing and improving this manuscript. Brian Parson (Trans North Helicopters) provided reliable and safe helicopter support.

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