MORTIMER HILLS PEGMATITE URANIUM PROSPECT A ROSSING-TYPE URANIUM DEPOSIT IN THE GASCOYNE PROVINCE

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ABSTRACT

A uraninite-bearing pegmatite of large dimensions in the Gascoyne Province is described. The pegmatite is compared with the Rossing uranium ore body of South West Africa and the two are shown to have common characteristics.

Exploration recommendations for Rossing-type uranium mineralization in the Gascoyne Province are made.

INTRODUCTION

Though the Gascoyne Province, with its multitude of small uranium deposits, could be classed as a uranium province, no deposit of this metal of obvious commercial dimensions has been found there, despite more than 10 years of sustained exploration. For example, Carter (1981) lists 63 items of the microfilm open-file in the library at Mineral House, Perth, which concern recent abandoned exploration for uranium in the province. Of these operations however, one (Item No. 723 in the microfilm catalogue), attracts attention because of its description of a large body of pegmatite carrying small amounts of uranium, situated just north of the Mortimer Hills. This pegmatite appears to have features in common with the low-grade ore body at the Rossing uranium mine in South West Africa, probably the world's largest uranium-in-granite mine. In an endeavour to assess whether Rossing-type mineralization may be present in the Gascoyne Province, characteristics of the pegmatite prospect and the Rossing ore body are reviewed and comparisons made.

The uraninite-bearing pegmatite lies three kilometres north of the Mortimer Hills (lat. 24°36″, long. 116°17″) and some 17 kilometres northeast of Yinnetharra, and is shown by symbol "U" on the Mount Phillips 1:250 000 geological sheet to occur within members of the Morrissey Metamorphic Suite of the Lower Proterozoic. Agip Nucleare Australia Pty Ltd explored the pegmatite between 1974 and 1978. The account of this prospect is drawn largely from reports of this company and a brief examination of the pegmatite and surrounding country made by the writer in September 1981.

ROSSING URANIUM DEPOSIT

The large but low-grade uranium occurrence at Rossing in South West Africa is composed of alaskitic granite*, pegmatite and aplite containing disseminated uraninite, betafite and secondary uranium minerals (Berning and others, 1976). These rocks were collectively called "pegmatite" and "potash granite" by early investigators before the term "alaskite" was employed.

The Rossing alaskites are situated within the central zone of the late Precambrian to early Palaeozoic Damara Orogenic Belt. Individual bodies range from lenses to large intrusive and replacement bodies differing widely in texture, size and replacement habit. Both concordant and discordant relationships are shown with marble, schist and gneiss of enclosing country rock. The alaskite occurs in syntectonic intrusions.

Disseminated uraninite (55% of the total uranium content of the ore) is included in quartz, feldspar and biotite but also occurs interstitially to these minerals, and along small cracks within them. It is accompanied by betafite (less than 5% of the uranium) and by secondary uranium minerals, including beta-uranophane and carnotite, which account for 40% of the total uranium content. The deposit is mined by a low-cost open-pit method and an acid leach process is used to extract uranium oxide.

Toens and Corner (1980) discussed the origin of the uraniferous alaskites:

"The polyphase Damara metamorphism produced high-grade metamorphic assemblages, migmatites and syn-, late- and post-tectonic anatectic granites through reactivation of the basement and overlying Damara rocks. During anatexis the

* Alaskite is used for granitic rock containing only a few per cent of dark minerals. It is characterized by essential alkali feldspar and quartz, and very little dark component.

incompatible elements, particularly the uranium derived from these formations, were incorporated into the melts which then rose . . .

"Fractional crystallisation during ascent and increased water content concentrated the uranium into residual melts which finally crystallized as alaskitic pegmatitic granite.

"Structural episodes played an important part in the emplacement of the uraniferous granites and the presence of marble bands was an important factor in . . . providing a structural trap for the alaskitic melts . . ."

MORTIMER HILLS PEGMATITE URANIUM PROSPECT

Exploration Status

The prospect was held by Agip Nucleare under MCs 09/1980 and 09/2174-2175. Uranium mineralization was initially detected by an airborne radioactivity survey, and the pegmatite became the target of intermittent investigations between 1974 and 1978. These included large-scale geological mapping (1:1 000), ground radioactivity surveys and drilling 33 non-core holes for a total of 440 metres. Drilling demonstrated a high geochemical content of uranium but was unable to locate ore-grade mineralization.

Geology

The Gascoyne Province, the tectonic setting of the Mortimer Hills pegmatite, is believed to have evolved during the interval 2 000 to 1 600 m.y. when an orogenic event modified Proterozoic shelf and trough sediments to form the Morrissey Metamorphic Suite. The suite, which includes amphibolite-facies rocks and migmatite, was intruded by Proterozoic granitoids. This orogeny possibly relates to a major world-wide event at about 1 900 to 1 700 m.y., this period being 'the earliest that uranium is known to have been mobilized and concentrated in veins' (Bowie, 1979). There is close correlation between the regional disposition of uranium-bearing pegmatites and the Morrissey Metamorphic Suite (Williams and others, 1979).

Uranium-bearing pegmatite forms two arcuate belts within migmatized Morrissey Metamorphic Suite rocks, as shown in Figure 1. Basement gneiss of uncertain age (either Archaean or Proterozoic) lies between these two belts and itself has above average background radioactivity. Williams and others (1979) considered that the basement gneiss was probably the source for the clastic arkosic rocks which were subsequently metamorphosed and migmatized to form the Morrissey Metamorphic Suite.

The emplacement of the pegmatites that contain the primary uranium mineralization post-dates the metamorphism and appears to be related to the late-stage tourmaline-bearing granites in the Nardoo area. Williams and others (1979) suggested that uranium in the pegmatite could have been scavenged from the meta-sedimentary rocks by volatile-rich hydrothermal fluids.

The generally uraniferous nature of this area is also shown by the number of calcrete uranium prospects that are spatially related to the primary pegmatite deposits.

The Mortimer Hills pegmatite lies within part of the Yinnetharra pegmatite belt which extends southeastwards from the Morrissey Hill district to Camel Hill. Pegmatites of this belt are well known for the small-scale production of mica (muscovite), beryl and bismuth. Uranium minerals are found among the accessory minerals, and pitchblende and euxenite have been identified, together with various secondary uranium minerals.

North of Mortimer Hills the pegmatite forms a low, northerly trending ridge. The main body has approximate dimensions of 1 000 metres in length and up to 400 metres in width, and was proved by drilling to extend to more than 81 metres in depth. Coarse quartz and potash and soda feldspars, the principal constituents, are accompanied by small amounts of muscovite, tourmaline, garnet, magnetite and calcite with a few scattered grains of metamict uraniferous pyrochlore. One specimen contained 90% potash feldspar, 5% quartz, 3% plagioclase feldspar and less than 1% each of muscovite, tourmaline, biotite and opaques. An analysis of a second sample returned the following results:

Al_2O_3 = 14.0%
CaO = 0.69%
MgO = 0.08%
Na_2O = 3.65%
K_2O = 4.05%
Fe_2O_3 = 0.71%

A third sample (Specimen GSWA No. 40773) is composed of albite, quartz and muscovite with a little almandine-spessartine, magnetite and calcite with a few scattered grains of metamict uraniferous pyrochlore and yellow joint stains of beta-uranophane. It assayed 210 ppm uranium (Government Chemical Laboratories Lab. No. 81 M2528). Drilling indicated that the pegmatite is predominantly muscovite bearing.

There is no obvious zoning in the pegmatite. Agip Nucleare reports that the contacts with the country rock, principally biotite schist of the Morrissey Metamorphic Suite, are diffuse along the eastern margin in contrast to the western flank where the contact is more abrupt.

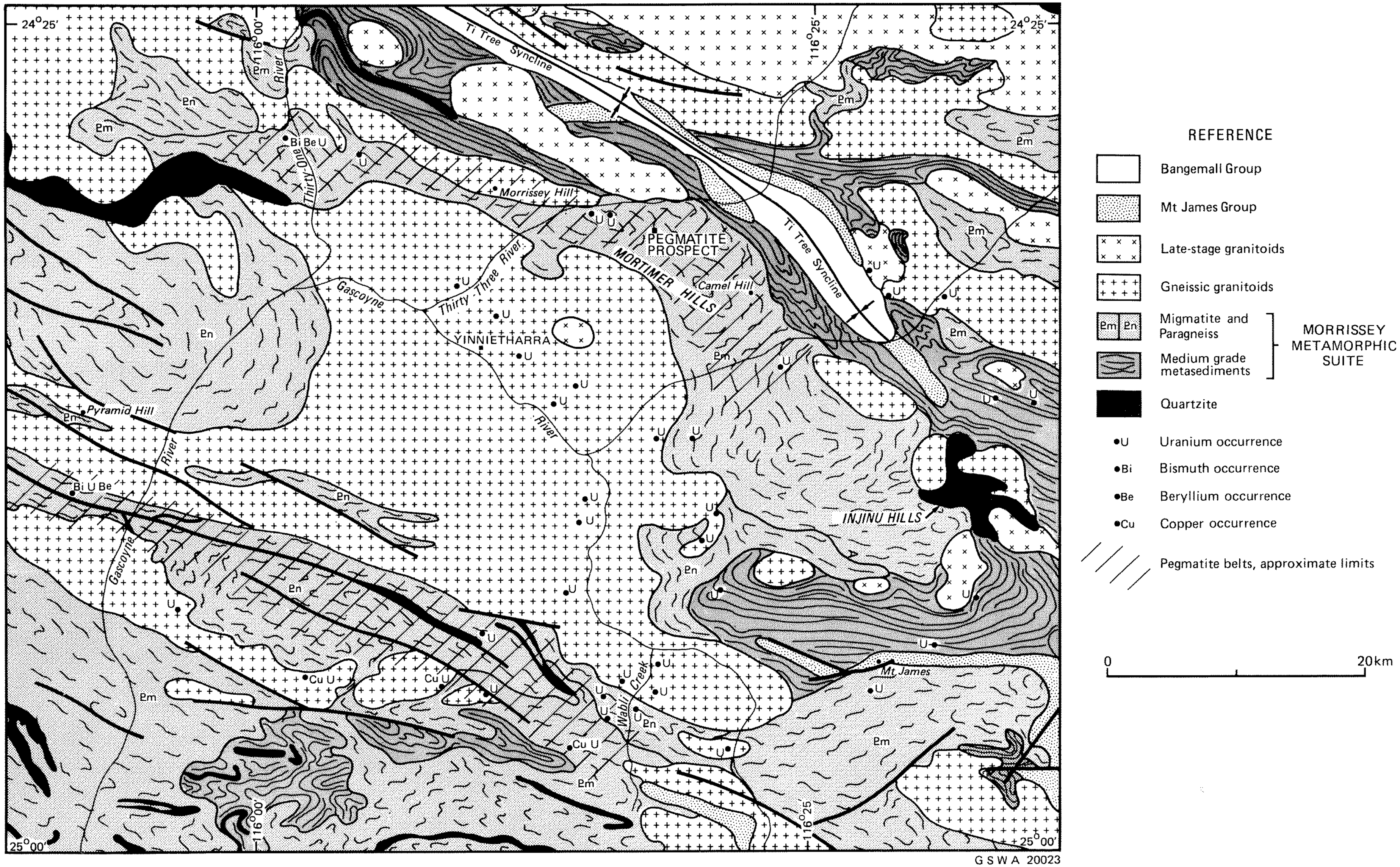

Figure 1. Geological map of the Yinnetharra district, showing distribution of two main pegmatite belts, the distribution of significant uranium and other mineral occurrences, and the location of the Mortimer Hills pegmatite uranium prospect. Geology adapted from the Mount Phillips 1:250 000 geological sheet.

Uranium mineralization is represented by uraninite, uranophane and beta-uranophane, and uraniferous pyrochlore. Uraninite occurs in small grains, some of which are embedded in mica flakes and in garnet grains. The best uranium value obtained by drilling was 150 ppm U over one metre.

Of six percussion drill holes sunk by Agip Nucleare, two reached 81 metres in depth. Most holes were sited over radiometrically anomalous high spots in the pegmatite and obtained sporadic, moderately anomalous uranium values throughout their lengths. There was, however, no recognizable correlation of anomalous zones between any of the holes nor apparent structural control of the uranium mineralization. Drilling near the western contact failed to detect evidence of uranium concentration in host rocks.

CHARACTERISTICS OF THE ROSSING GRANITE AND MORTIMER HILLS PEGMATITE

In Table 1, characteristics of the Rossing granite and Mortimer Hills pegmatite are set out for ease of comparison. Many similarities between Rossing granite mineralization and the Mortimer Hills pegmatite prospect are shown. The lithologies of the mineralized rocks, the nature of mineralization, the structures of the host rocks and their probably modes of emplacement correspond closely.

Of the dissimilarities, no importance can be discerned in differences of age and time in relation to orogenic events which determine structural settings. A further difference is the proportion of biotite and muscovite. Toens and Corner (1980), in discussing criteria favourable for uranium mineralization, found biotite to be an essential accessory mineral and state "that muscovite . . . should be present only in small amounts". The reverse is true in the case of the Mortimer Hills pegmatite.

These authors also believe the "level of erosion is extremely critical in determining the current economic potential of a mobile belt" and state that "In general, the older the belt the more erosion it has been subjected to". A result could be the stripping of high-level, mineralized granitic differentiates. Examples are provided from South Africa: the Damara (c. 500 m.y.), the Namaqua (c. 1 000 m.y.) and the Limpopo (c. 1 950 m.y.) belts where uraniferous alaskitic granites, while known in the Damara belt, are rare in the Namaqua belt and are unknown in the Limpopo belt.

TABLE 1

Characteristics	*Damara Orogenic Belt and Rossing granite (Berning and others, 1976; Toens and Corner, 1980)*	*Gascoyne Province and Mortimer Hills pegmatite (Agip Nucleare)*
Structural setting	Orogenic belt	Orogenic belt
Age	Late-Precambrian to early Palaeozoic; Rossing granite: c. 470 m.y.	Lower Proterozoic 2 000-1 600 m.y. Pegmatite: (?)c.980 m.y.* (but most probably older than 1 100 m.y.)
Country rocks	High-grade metamorphic rocks and migmatite intruded by syn-, late- and post-tectonic anatectic granites	High-grade metamorphic rocks and migmatite intruded by early- and late-tectonic granitoids
Mineralized rocks	Late-tectonic alaskitic granite, pegmatite and aplite	Post-orogenic alaskitic pegmatite
Principal accessory mineralogy	Biotite, muscovite and amphibolite minerals in small amounts	Muscovite the major accessory, and tourmaline; biotite in small amounts
Uranium minerals	Uraninite, betafite and secondary uranium minerals	Uraninite, uraniferous pyrochlore and secondary uranium minerals
Grade of mineralization	Not known but probably very low, may be much less than 1 000 ppm U_3O_8 (?); reported daily milling rate is 40 000 tonnes with annual production 5 000 s tons U_3O_8	Best drill intersection 150 ppm U over 1 metre
Structure	Massive bodies of alaskite	Compact and massive pegmatite
Mode of emplacement	Passive metasomatic process	Passive emplacement
Structural control	Marble bands apparently entrapped uranium-rich volatiles	None recognized
Level of erosion of structural setting	Considered to be shallow as "high-level" mineralized granites are exposed	Probably deeply eroded

*See Wilson and others, 1960.

This generalization does not hold for the Mortimer Hills pegmatite, a mineralized differentiate within an older mobile belt where exposures of rocks of amphibolite facies suggest deep erosion has taken place. Also, the pegmatite was generated either at a late stage of, or after the evolution of the Gascoyne Province. The age of the pegmatite (c. 980 m.y.), published in 1959, is considered to be too young. Gascoyne Province pegmatites are older than Bangemall Group rocks and these are dated c. 1 100 m.y. The Mortimer Hills pegmatite, exposed with rocks of the amphibolite facies and older than c. 1 100 m.y., therefore belies the importance attached by Toens and Corner (1980) to levels of erosion, and to ages of c. 1 000 m.y. or less, factors which could otherwise down-grade the potential of the Gascoyne Province for Rossing-type uranium mineralization.

Another factor is the apparent role of marble bands which acted as traps for alaskitic melts and associated uranium-rich volatiles at Rossing, to which reference has already been made. Toens and Corner (1980) state that "in alaskites with high oxygen fugacity at the magmatic stage, the uranium will be mostly in the hexavalent state and the uranium will leave the magma with the solution during the boiling of the magma and the alaskite will thus not be mineralized". Marbles appear to have played an important role as an entrapment agent at Rossing by forming impermeable barriers to mineralized volatiles. No structural control of the Mortimer Hills pegmatite was noticed. This may account for the low tenor of uranium mineralization.

SUMMARY

The Mortimer Hills uraniferous pegmatite is regarded as a weakly mineralized representative of Rossing-type uranium mineralization. An immediate question is: are there more strongly mineralized alaskitic rocks elsewhere in the Gascoyne Province? In light of the lack of success of extensive exploration for uranium in this mobile belt, it must be assumed that high-grade mineralization of the Rossing-type with strong radiometric signals easily detected by airborne radioactivity surveys is either not present, or is not exposed. To test the latter possibility, exploration attention should be given to unexposed sections or extensions of the "two arcuate belts" containing pegmatites in the country south of Yinnetharra.

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