



# Minerals in Afghanistan

## Rare-metal deposits

### Introduction

In Afghanistan rare metals (lithium, caesium, tantalum and niobium) occur in three main deposit types: pegmatites, mineralised springs and playa-lake sediments (Figure 1). The most potentially significant, easily extractable resources of rare metals in Afghanistan occur in mineralised springs and playas, although there is also considerable potential for exploiting hard-rock pegmatite deposits. Globally, rare metals

are produced from deposits in these three settings, chiefly in Chile, Argentina, the USA and Turkey. Lithium has many uses, for example in batteries, in the glass and ceramics industry, and in high performance alloys for aircraft. Most tantalum is used to produce capacitors that are used in laptop computers, mobile phones and digital cameras. Niobium is primarily used in specialist steels although it also shares some uses with tantalum since it has almost identical chemical properties.

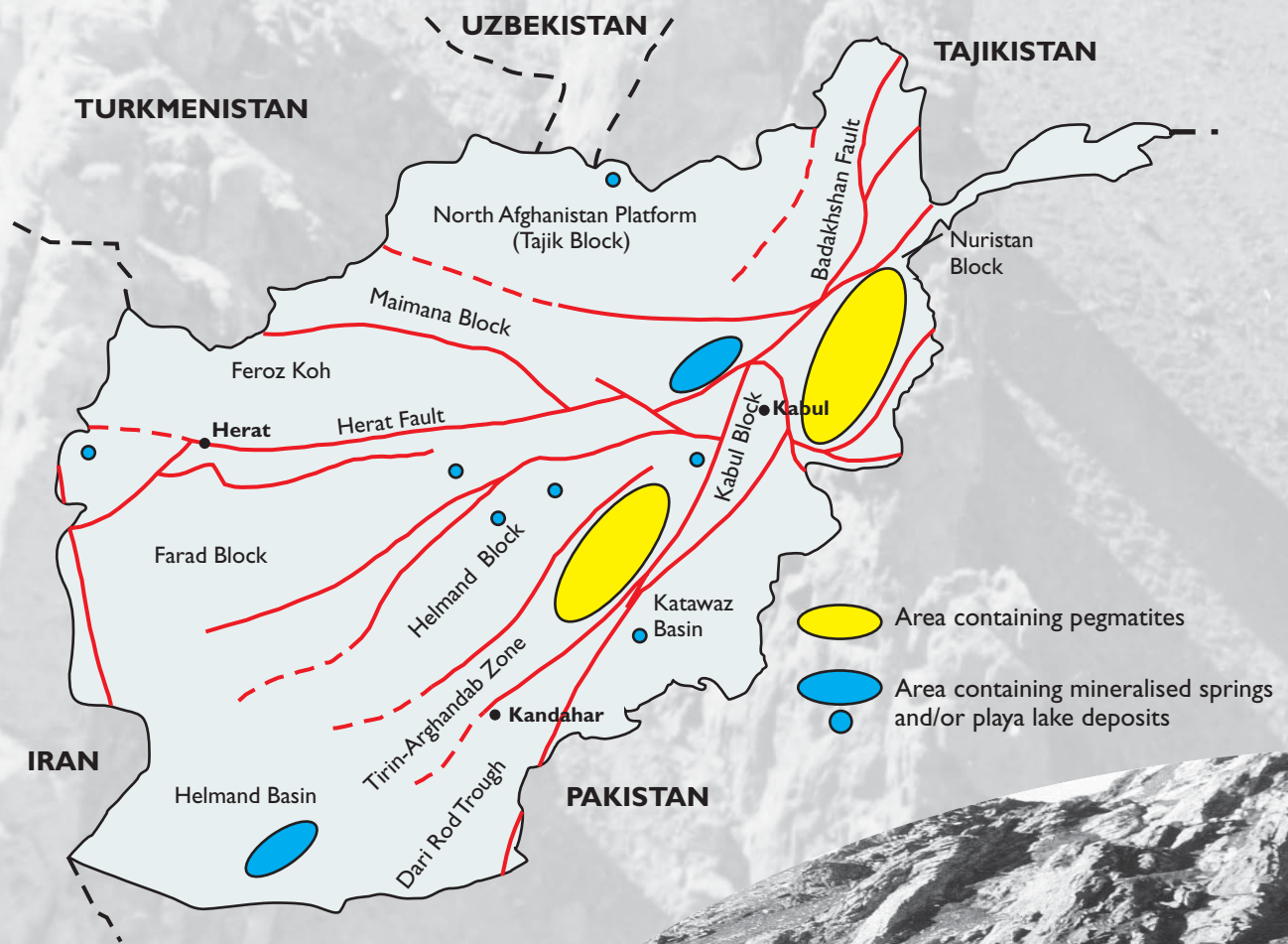


Figure 1. Tectonic map of Afghanistan showing major blocks and faults and location of rare metal deposits.



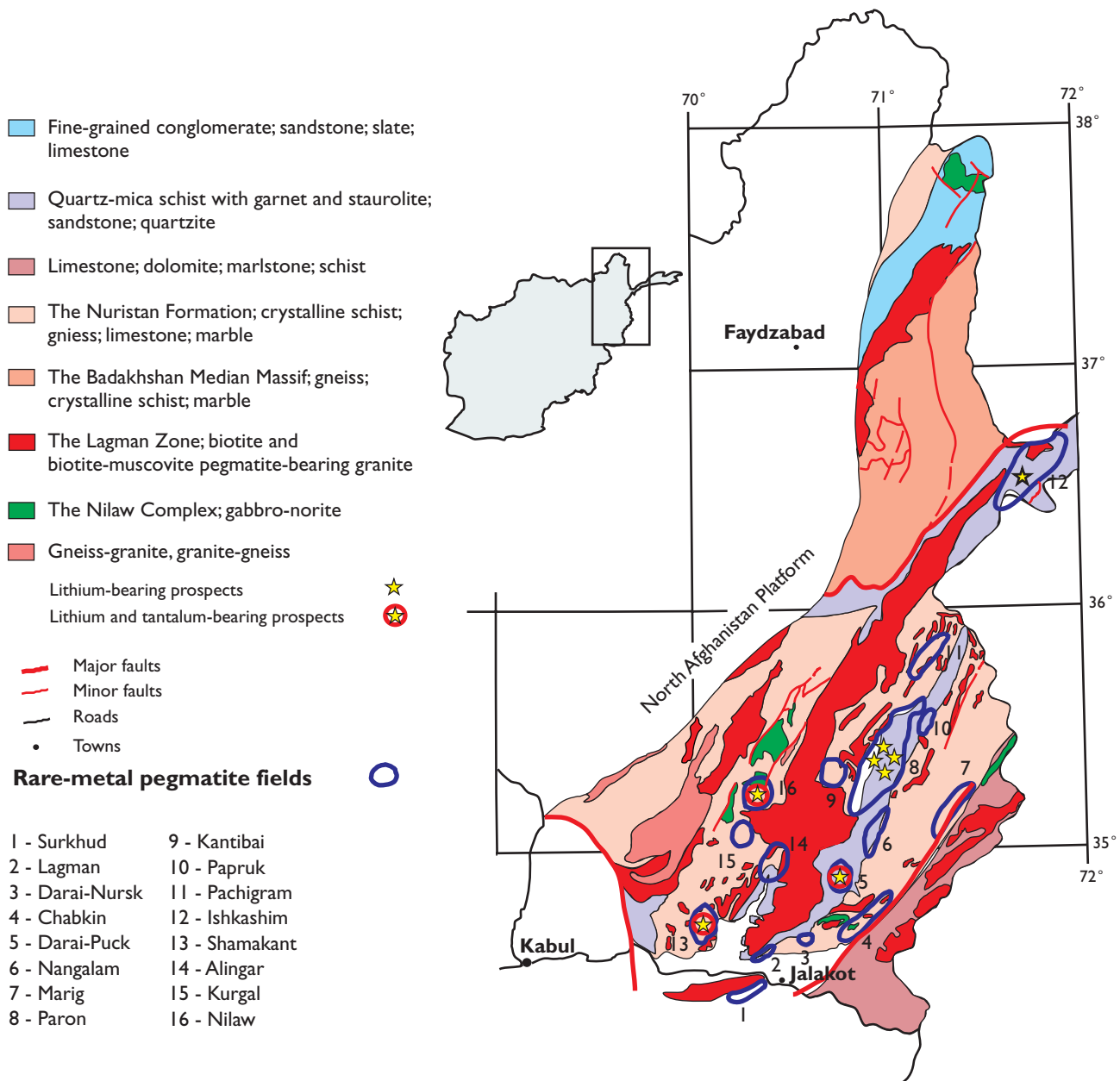


Figure 2. Distribution of rare-metal pegmatites in eastern Afghanistan.

Pegmatites have been known in eastern Afghanistan since ancient times and are still exploited for precious stones, such as kunzite and aquamarine, using small-scale surface and underground excavations. The first rare metal extraction was carried out between 1950 and 1960 in the pegmatite fields at Dara-i-Nur where 130 tons of beryl was

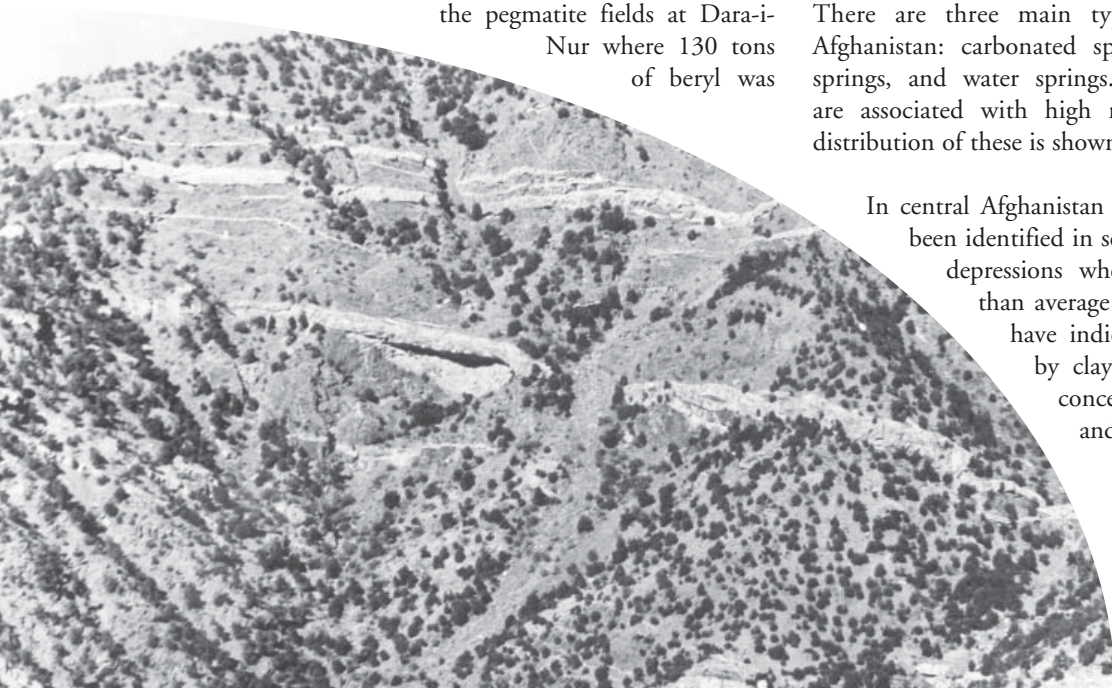
produced by open-cast mining of pegmatite veins. Subsequent exploration for beryl at the Dara-i-Pech pegmatite field between 1963 and 1964 also identified large pegmatite fields nearby at Nilaw and Parun.

There are three main types of mineralised spring in Afghanistan: carbonated springs, nitrous and sulphurous springs, and water springs. Only the carbonated springs are associated with high rare-metal concentrations. The distribution of these is shown in Figure 1.

In central Afghanistan occurrences of rare metals have been identified in sediments below several lakes and depressions where lake brines contain higher than average metal concentrations. Trial pits have indicated that salt deposits covered by clay and loam layers contain high concentrations of lithium, boron, lead and zinc.

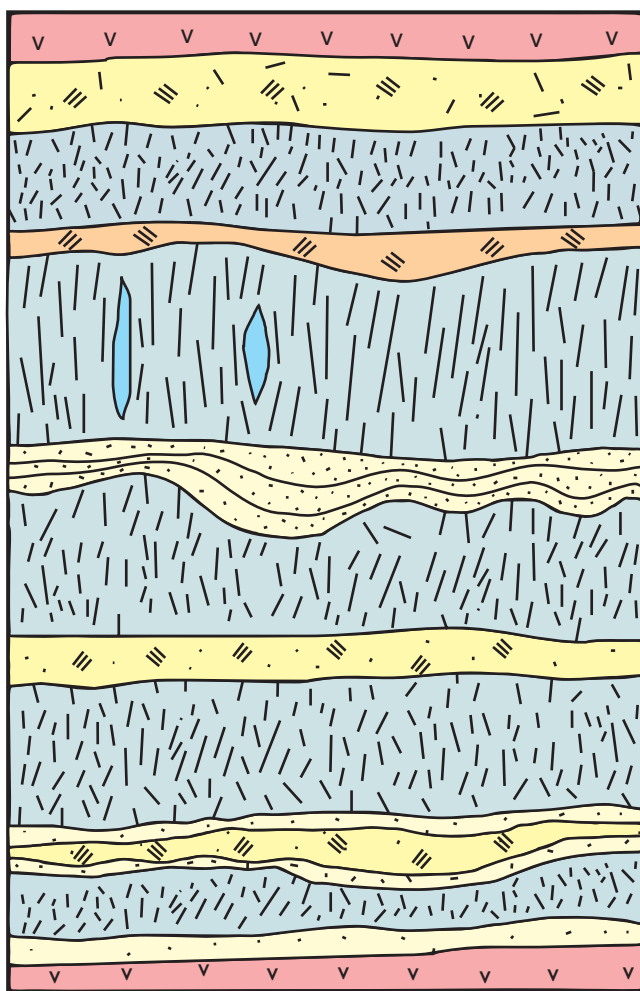
#### Previous exploration

No systematic exploration or assessment of pegmatites,



mineralised springs, or sedimentary deposits of rare metals took place prior to an extensive Soviet-Afghan exploration programme undertaken throughout Afghanistan from 1971 to 1974. These surveys identified mineralised springs, three pegmatite fields in eastern Afghanistan, one in Oruzgan province in central Afghanistan, and several sedimentary deposits of rare metals, also in central Afghanistan.

The exploration programme determined that rare-metal pegmatites in Afghanistan are predominantly spatially and genetically associated with Cretaceous–Palaeogene granites hosted within quartz-mica schist, gneiss, and gabbro-diorites. Many of these pegmatites have concentrations of Li, Ta, Cs, Be, Sm and precious stones that are of potential commercial interest. The most promising discoveries were for lithium in the Parun pegmatite field (Figure 4) and for tantalum in the Nilaw-Kulem field (Figure 5).









-  Country rock (gabbro, norite)
-  Aggregates of thin tabular albite
-  Coarse-grained crystalline spodumene
-  Fine-grained lepidolite-albitic margin
-  Lepidolite
-  Lens-like crystals of microcline

Figure 3. Typical schematic zonation (1–40 m) around a pegmatite vein in eastern Afghanistan.

### Rare-metal pegmatite deposits

Most pegmatite fields occur in the east of the country (Figure 2) with a smaller number in south-central Afghanistan. Those in the structurally complex north-east part of the country extend for up to 400 km, whilst the Oruzgan province field extends for over 200 km. The majority of eastern Afghanistan consists of the Nuristan Fault Block composed of Lower Proterozoic metamorphic rocks intruded by a series of Cretaceous-Tertiary biotite-granite and granodioritic intrusions known as the Lagman Complex or Lagman Zone. This zone extends for hundreds of kilometres through Badakhshan, Nuristan and Lagman provinces and continues into Oruzgan province. The largest single intrusion within the Lagman Zone, the Alingarski Intrusive, has an outcrop width of 10–50 km and stretches continuously for over 200 km.

Pegmatites are spatially related to the margins of the Lagman Zone. The Soviet-Afghan exploration programme recorded seven types of pegmatites, ranging from a plagioclase-microcline type containing little rare metal mineralisation, to more potassium-rich albitic veins with more abundant rare metals. The rare metal-rich albitic pegmatites contain up to 1.5–2.5 %  $\text{Li}_2\text{O}$  or 20–30 % spodumene, together with occasional columbite-tantalite and cassiterite.

Spatial zonation of pegmatite mineralogy around the granites is commonly observed. High temperature microcline-dominated veins generally occur close to the intrusions, while spodumene-bearing veins occur in lower temperature distal settings. This is a potentially useful tool for further exploration for rare metal rich veins associated with the Lagman Zone intrusions. However, this zonation is not uniform, and limited work undertaken by the Soviets has identified albitic veins containing almost no spodumene but with tantalum mineralisation. The typical zonation around a pegmatite vein in eastern Afghanistan is shown in Figure 3.

The pegmatites have not been dated, but the Oligocene age of the Lagman granites suggest the pegmatites have a similar age. The Soviet-Afghan exploration in the 1970s indicated that most pegmatites vary in thickness from a few metres up to about 40 m, and can be traced for distances from 10 m up to 4 km.

In eastern Afghanistan, the majority of the most economically attractive pegmatites occur within two zones either side of the most continuous part of the Lagman Zone granite, trending in a north-east orientation (Figure 2). The pegmatite-bearing zones pinch out where the Proterozoic rocks are no longer present to the east of Kabul, where the Kabul Block abuts against the North Afghanistan Platform. A smaller number of pegmatites are also found in association with granites and granodiorites of the Lagman Zone to the west of the Kabul block.

Lithium, in the form of spodumene, has been recorded in 12 pegmatite fields or districts mostly located in Nuristan, Badakhshan, Nangarhar, Lagman and Uruzgan provinces (Table 1).

Fourteen tantalum- and niobium-bearing pegmatite fields are known in Afghanistan and were examined during the Soviet exploration programme from 1971 to 74. Few of these



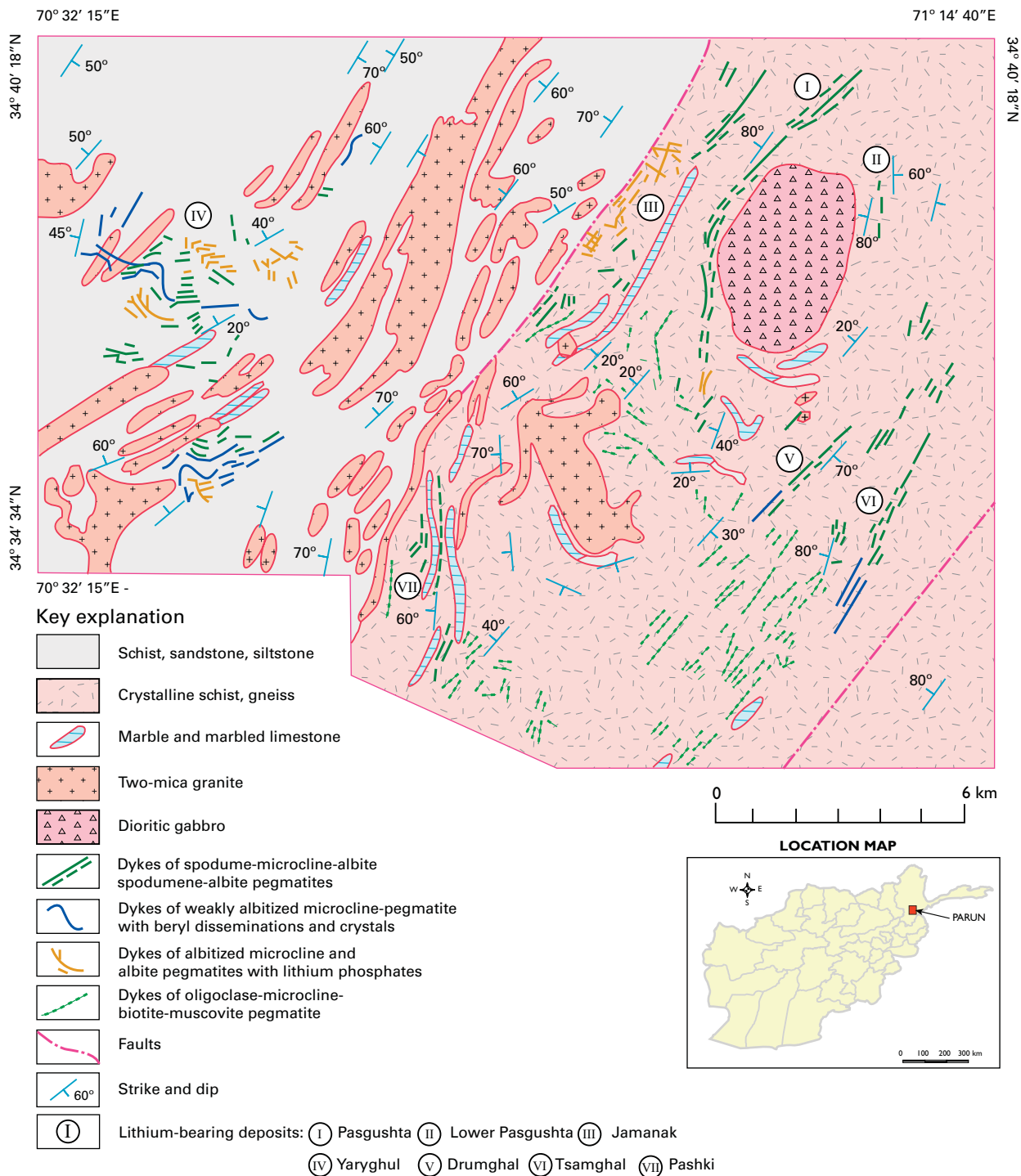
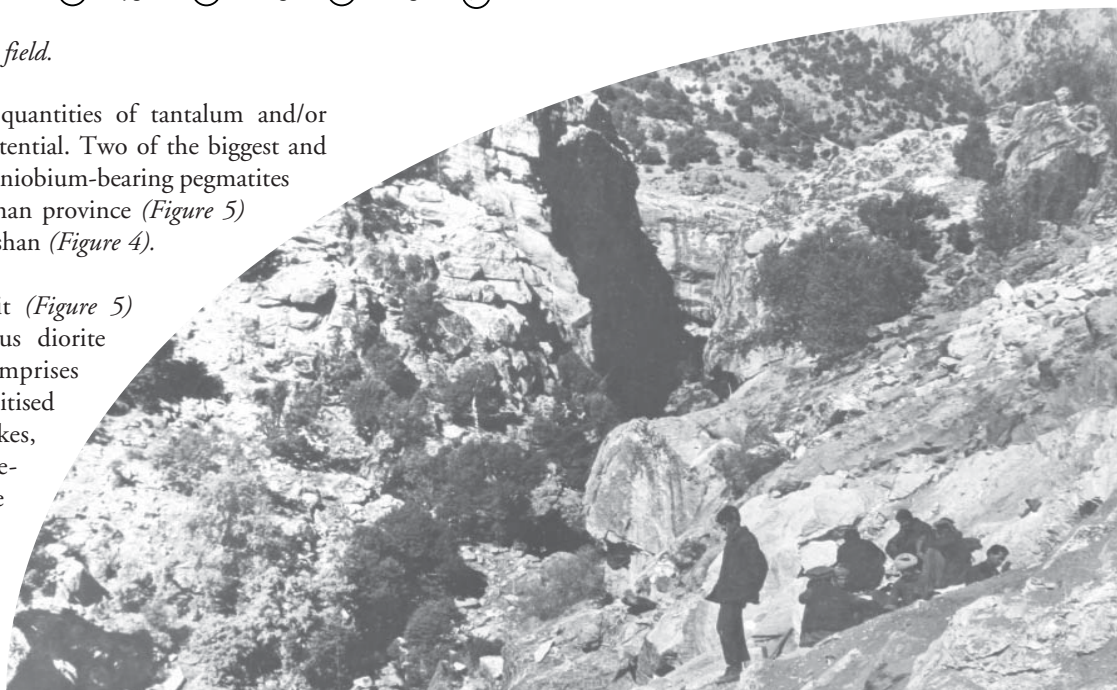


Figure 4. The Parun rare-metal field.

pegmatites contain adequate quantities of tantalum and/or niobium to have economic potential. Two of the biggest and most promising tantalum- and niobium-bearing pegmatites are the Nilaw deposit in Lagman province (Figure 5) and the Parun field in Badakhshan (Figure 4).

The Nilaw rare metal deposit (Figure 5) is hosted by Early Cretaceous diorite and diorite-gabbro and comprises three types of pegmatites: albitised microcline dykes, albite dykes, and lepidolite-spodumene-albite dykes. Of these, the third contains the highest concentrations of rare metals



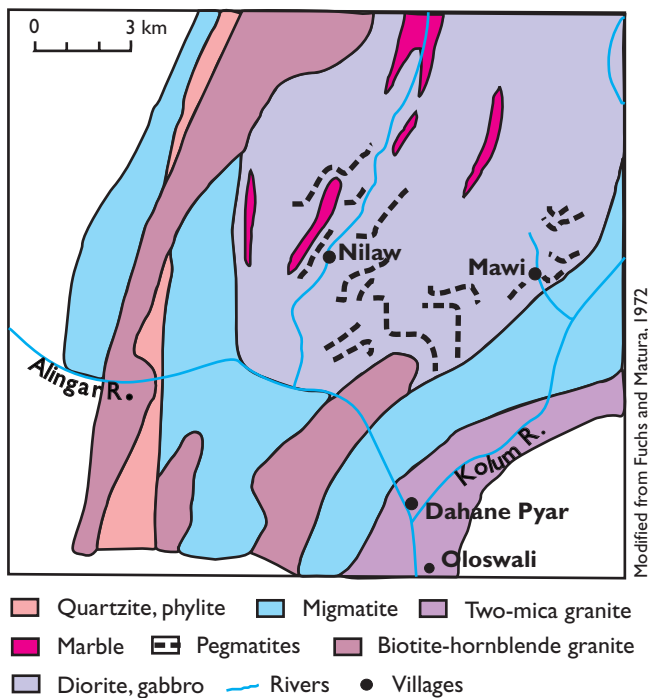


Figure 5. Geological sketch map of the Nilaw area.

and is the most prospective. The lepidolite-bearing dykes, 3–5 m wide, can be traced for 2–4 km. They include columbo-tantalite, mangano-tantalite, microlite, disseminated beryl, and cassiterite with Russian data recording an average grade of 17 g/t tantalite in the pegmatite.

#### Rare metal mineralised spring deposits

Mineralised waters tend to occur in association with volcanic rocks in zones affected by recent magmatism and faulting. Mineralising springs with high concentrations of rare metals are commonly associated with carbonate-rich fluids that have ascended through faults in fractured carbonate rocks.

In Afghanistan mineralised springs occur mainly at the junction of the Main and Helmand-Argandab zones to the west of Kabul (Figure 1). In the Qala-Gorband-Turkman subzone a unique thermal water basin occurs with more than 30 springs that discharge water at a rate of 0.01 to 3.5 l/s. These springs contain high concentrations of Li, Rb, Cs, B,

Ge of potential commercial value, and are also enriched in Be, As and Fe.

Several springs near the mouth of the Namakab River in the Qala-Gorband-Turkman subzone have very high reported concentrations of Li, Rb, Cs and B. Springs in the Qala area have a discharge rate of about 10 l/s and Soviet analyses have recorded 10 mg/l Li, 2 mg/l Rb, 2 mg/l Cs, and 450 mg/l  $\text{BO}_2$ . Estimates from this work indicate that these springs discharge 3153 kg Li, 630 kg Rb, 630 kg Cs and 38,700 kg  $\text{BO}_2$  per year. Other springs in the Qala Valley are reported to produce approximately 180 l/s. It is therefore possible that considerably greater quantities of rare metals are being precipitated and these represent attractive targets for mining companies.

Mineralised springs are also commonly associated with pegmatites and with metallogenic belts throughout Afghanistan. However, only the carbonated springs are associated with rare metals and these usually occur in fractured carbonate units associated with relatively recent magmatic activity.

#### Rare metal playa-lake deposits

The salt deposits in Lake Sar-i-Namak in Takhar province are reported to contain 0.02 % Li, while the lake brine has a lithium content of 350 mg/l and a high boron content. Limited work carried out during the Soviet-Afghan exploration of the country indicated that the clay underlying Lake Ab-i-Estoda in Ghazni province contains more than 1 % B. Given that the lake extends over about 100 km<sup>2</sup>, the potential resource of boron in this area is considerable and deserves further work. The Namaksar-Herat Lake in the Ghuryan district of Herat province is also reported to contain high levels of Li and B in both the lake brine and underlying salt beds. A diagram illustrating how a playa lake is formed is shown in figure 6.

#### Conclusions and potential

Afghanistan has considerable resources of rare metals in pegmatites, mineralised springs and lake-sediment salts. No systematic modern exploration has been carried out since the withdrawal of Soviet forces and many of the known localities warrant further investigation and exploration based on modern mineral deposit models and techniques.

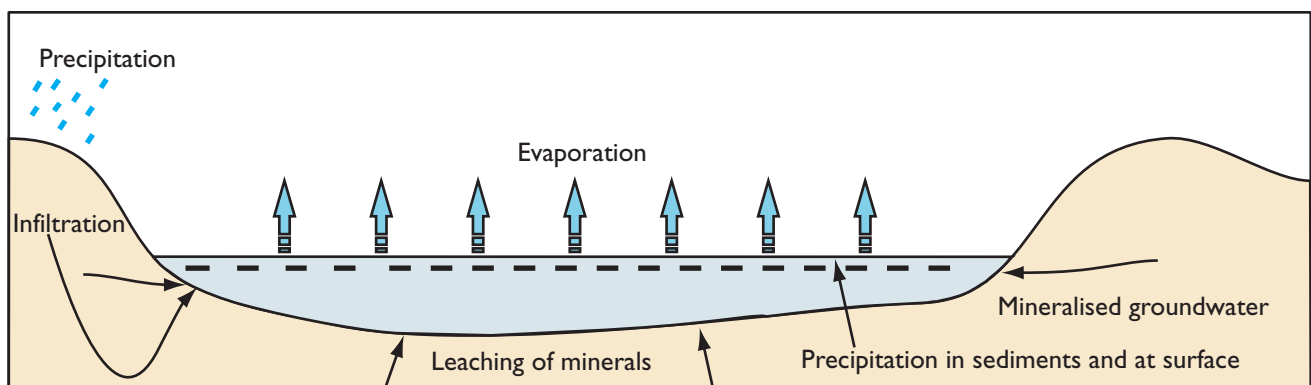


Figure 6. A schematic representation of a playa lake.

Deposit name and co-ordinates	Geology of deposit	Areal extent	Deposit size and grade	Notes
Pasghusta 35°23'34" N 71°00'56" E	Upper Triassic slate with steep spodumene-bearing dykes	10 km long and 30 to 250 m wide	1.96 % Li <sub>2</sub> O over 70 m, and 2.14 % Li <sub>2</sub> O over 20 m in three dykes. The deposit also recorded 0.022–0.007 % Ta <sub>2</sub> O <sub>5</sub>	The largest individual dykes are 600–800 m long and 20–30 m wide. These also contain disseminated columbo-tantalite and cassiterite
Jamanak 35°23'12" N 70°59'06" E	Triassic metamorphic rocks intruded by spodumene-bearing pegmatite dykes	Four zones up 1 km long and 10–20 m wide	450,000 t of Li <sub>2</sub> O over 6 km averaging not less than 1.5 % Li <sub>2</sub> O	
Yaryhgul 35°22'40" N 70°50'51" E	Foliated and migmatized Proterozoic schists intruded by Oligocene granite and pegmatite dykes	3 km by 5 km	Speculative reserves for five veins totalling 3.5 km long, 3 m thick and to a depth of 100 m are 130,000 t Li <sub>2</sub> O, averaging 1 % Li <sub>2</sub> O	The pegmatites are 500–3,500 m long, 1.5–5 m thick and contain 15–25 % spodumene
Lower Pasghusha 35°22'52" N 71°03'06" E	Two pegmatite dykes hosted by Upper Triassic carbonaceous-sericite-quartz slate	Pegmatites 500–750 m long and 20–25 m thick	The dykes average 2.2% Li <sub>2</sub> O with a maximum value of 2.31 %. Speculative reserves are 124,000 t Li <sub>2</sub> O to a depth of 100 m	Up to 30 % spodumene in pegmatities
Paskhi 35°17'30" N 70°57'30" E	Three pegmatite dykes intruding Upper Triassic rocks	2 km by 3.5 km	Two dykes assay 1.46 % Li <sub>2</sub> O and 1.56 % Li <sub>2</sub> O. Individual dykes assay 0.01–0.02 % Rb and Cs, 0.002–0.008 % Ta <sub>2</sub> O <sub>5</sub> , and 2.1 % Li <sub>2</sub> O. Speculative reserves for all three dykes of 127,000 t Li <sub>2</sub> O to a depth of 100 m	The first dyke, 1000 m long by 7.5–60 m thick, is exposed down dip for 600 m and contains 15–25 % spodumene. The second pegmatite includes en-echelon and sub-parallel dykes and occurs over a length of 2.5 km and is 5–10 m thick
Tsamgal 35°17'45" N 71°02'31" E	Upper Triassic carbonaceous-quartz-biotite slates intruded by spodumene bearing dykes	Individual pegmatite dykes are commonly 600–1,000 m long, 3–7 m thick	At least 1.5 % Li <sub>2</sub> O and one dyke recorded 2.32 % Li <sub>2</sub> O. Speculative reserves to 100 m are 187,500 t Li <sub>2</sub> O at 1.5 % Li <sub>2</sub> O	
Drumgal 35°19'08" N 70°01'21" E	Upper Triassic slate intruded by three spodumene-bearing pegmatite dykes	Individual pegmatite dykes are between 1,000–2,000 m long and 7-30 m thick	The whole deposit grades 1.38–1.58 % Li <sub>2</sub> O. The thickest part of the pegmatite contains 1.38–1.58 % Ta <sub>2</sub> O <sub>5</sub> . Speculative reserves to a depth of 100 m are 253,000 t Li <sub>2</sub> O	

Table 1. Rare metal pegmatites in Afghanistan.

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