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INTERNATIONAL URANIUM RESOURCES EVALUATION PROJECT

I U R E P

NATIONAL FAVOURABILITY STUDIES

AFGHANISTAN

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C O N T E N T S

SUMMARY

Although Afghanistan has an extent of some 650,065 square kilometres, only a very small proportion of it has been surveyed for uranium, and that only at the preliminary reconnaissance stage.

Earlier work by bi-lateral teams identified a number of small uranium anomalies and occurrences and more recently (1974-75) an IAEA geologist discovered evidence of uranium mineralisation in the Neogene - Lower Pleistocene continental sediments of the Jalalabad Basin to the east of Kabul. The I.A.E.A. expert outlined three areas totalling 20,000 km^2 where systematic uranium exploration would be justified. Up to the present no positive programme has been agreed.

On very tenuous evidence a Speculative Potential of 2000 tonnes U_3O_8 is suggested for Afghanistan.

Category 2. 1000 - 10,000

1. INTRODUCTION AND GENERAL GEOGRAPHY

Afghanistan is a country in central Asia, bounded in the north by the USSR, in the west by Iran, in the south and south-east by Pakistan and in the east by China. It has an area of 251,000 sq. miles or 650,065 sq km.

The dominant feature of Afghanistan is the great central range of mountains which divides the country approximately from east to west. This range, known in its eastern portion as the Hindu Kush, takes off from the Little Pamir in the extreme northeast, and after forming the boundary between Chitral and Afghanistan to a point south of the Dorah pass turns westward and spreads across central Afghanistan in a series of deep ravines and broken ridges gradually diminishing in height from the eastern peaks of 24,000 ft. Opposite Kabul and some 150 miles to the north of it the main ridge rises to peaks of about 20,000 ft. Farther west it spreads out fanwise in a series of subsidiary ranges, such as the Paghman range (16,000 ft.), while the main ridge continues westward under the names of the Koh-i-Baba (15,000 ft.), the Band-i-Baian (13,000 ft.) and the Band-i-Baba (12,000 ft.), and finally the Paropamisus mountains which continue as a series of low ridges in a northwesterly direction till they reach the valley of the Hari Rud.

There are no railways in Afghanistan. Main roads connect the principal centres of the country and link up with the road system of Pakistan at Torkham and Chaman, and with Iran at Islam Kila, west of Herat. A road driven through the passes of the Hindu Kush to connect Kabul directly with the northern provinces was opened in 1933 and in the following 12 years fair-weather roads to all the larger towns were constructed. The main roads, though usually metalled, are rough and liable to be blocked by snow or damaged by floods in the winter and spring. Motorbus services ply on these with fair regularity.

2. GEOLOGY OF AFGHANISTAN IN RELATION TO POTENTIALLY FAVOURABLE URANIUM BEARING AREAS

Except for the relatively stable block of the North Afghan Platform, Afghanistan is situated largely in the Alpine mobile belt.

The mobile belt consists of marine geosynclinal sediments, showing various degrees of metamorphism, along with the normal assemblage of basic igneous material and intrusive granitic rocks. Orogenic events have taken place from the Pre-Cambrian to the Oligocene and can be summarized as follows. Archaean-Lower Proterozoic and Middle-Late Proterozoic orogenies have been established and are preserved as uplifted blocks in the mobile belt. Two further major cycles of tectonism and magmatism followed: Palaeozoic-Early Mesozoic (subdivided into minor events in the Carboniferous-Permian, Late Permian-Early Triassic and Late Triassic-Early Jurassic) and Late Mesozoic-Tertiary (consisting of events in the Early Cretaceous, Late Cretaceous- Palaeocene and Eocene-Oligocene). Since the Palaeozoic, the axes of the mobile zones have migrated southward with each successive event (Figure No. 1).

North Afghan Platform

The North Afghan Platform is bounded on the east by the Hindu Kush and Badakhshan Ranges and on the south by the Safed Koh and Paropamisus; the rocks forming its basement stage pass northward under Tertiary and Recent cover into the Soviet Union.

Stabilization of the North Afghan Platform took place in the late Mesozoic and subsequent sedimentation occurred largely in a marine environment until the Early Tertiary and was then replaced, starting from the west, by a continental phase.

The oldest exposed rocks of the North Afghan Platform consist of Carboniferous and Permian. They appear to have been deposited on older Palaeozoic and crystalline basement, as revealed by deep gas and oil drilling.

Carboniferous-Permian

The Carboniferous and unconformably overlying Permian were deposited in coastal marine and sometimes deltaic conditions (Mikhailov et al., 1967). Both formations consist of sandstones, siltstones and argillites with minor limestones. The Palawan Suite of the Carboniferous contains poor coals up to 2 m. thick and carbonaceous siltstones in addition to quartz- and basalt-porphyries. Conglomerates in the Permian have some granite pebbles. The lower half of the Permian is represented by red coloured deposits and is succeeded by a grey succession. Pre-existing granitic rocks now exposed to the south could have acted as source rocks for uranium.

Triassic

The Triassic succeeds the Permian unconformably north of the Paropamisus and west of the Hindu Kush.

Structural and erosional inliers of Triassic rocks are found from Herat in the west to a point north of Kabul in the east. In the Herat area, with the exception of a small area of Jurassic at Masjit-i-Chubi, they are overlain unconformably by the Cretaceous.

In the Bande-Turkestan Range and in the inliers to the east and southeast the Triassic consists mainly of sandstones, siltstones and argillites with very minor limestone and conglomerate. The Middle Triassic has some thin volcanics in the western part of the Bande-Turkestan. Minor accumulations of plant debris are found in Lower Triassic sandstones and siltstones about 35 km. north of Herat and significant amounts of coaly material occur in a predominantly argillitic succession at Qaflatun, 28 km. south-southwest of Sar-i-Pul.

Further east, where the Triassic is overlain by the Jurassic, its character becomes rather more continental. Here, the middle division of the Trias consists mainly of acid and basic lavas with thin bands of detrital rocks containing a marine fauna and minor plant debris - possibly indicating littoral conditions.

In the Upper Trias the Carnian-Norian stages consist of coaly argillites with plant debris, siltstones and sandstones with marine fauna and plant fossils.

Jurassic

With the exception of the minor area already noted at Masjit-i-Chubi about 90 km. northeast of Herat all the continental Jurassic outcrops lie east of the 65° east meridian and amount to a total of 600 sq. km. but a greater area could well occur beneath younger cover rocks.

The zone of outcrop is 300 km. long and 20-50 km. wide. Generally speaking the Jurassic was laid down in intermontane basins but marine transgressions have been proved in the late Middle and Upper Divisions at Pul-e-Khumri and Chal-Namakab.

The provenance of the detrital material feeding the Jurassic intramontane basins appears to have been from an area of possible Pre-Cambrian or Palaeozoic rocks north of the depositional basin or from the south and east - the present day Koh-i-Baba and Hindu Kush. Pre-Jurassic granites certainly occur south and east of the Jurassic basins as now exposed.

The lithologies of the Lower and Middle Jurassic are fairly consistent from Darra-e-Suf in the west to Chal-Namakab in the east and they are characterized by a recognisable cyclic rhythm. Sandstone and siltstone are present in variable quantities with sandstone: siltstone ratios from 3:1 to 1:1.5 on different measured sections. The remainder of the sections is made up of conglomerates, pebble beds, argillites and coal.

Individual sandstones in the Lower-Middle Jurassic can be up to 30 m. in thickness and are fine to coarse grained and coloured in shades of gray, brown and red. They are often polymictic in composition, with tuffaceous, arkosic and feldspathic varieties. Plant debris is present in places andrare limonite concretions after marcasite have been noted. Coals are reported up to 10 m. thick but are of low quality and are often severely crushed and powdery due to their complex tectonic history.

As far as the Upper Jurassic is concerned the sections in the Darra-e-Suf and Doab-Ishpushta regions remain continental in nature but are rather more conglomeratic.

Cretaceous

The "Red Grit" of Neocomian-Aptian age lies with slight unconformity on older rocks in the eastern part of the North Afghan Platform. It consists of conglomerates, pebble beds, sandstones and siltstones accompanied by clays and rare limestones. The thickness varies from 1000 m. at Ishpushta to 400 m. at Pul-e-Khumri. Dips are usually shallow but can be steep near faults. The "Red Grit" is succeeded by a marine carbonate succession of Albian age.

Although they are reputed to be of intramontane continental origin, no mention has been made in any of the descriptions of fossil organic debris.

Tertiary Intramontane Basins

General

Sedimentary basins of Tertiary age (mainly Neogene) are widespread throughout Afghanistan (Figure No. 1) except in the northeast corner and in the central part of the country. They range in size from a few hundred to approximately 120 000 sq. km. in area.

Tertiary sediments overlie and are derived from a variety of rock types and are frequently succeeded and concealed by Quaternary formations. They generally consist of thick coarse basal conglomerates which are followed by an alternation of conglomerates, sandstones and argillites. The thickness of the sediments in the basins varies from about 1000 m., as at Bamyan, to as much as 16 000 m. in the east of the North Afghan Platform.

The conglomerates are often extremely coarse, with a sandy, silty or marly matrix. They reflect the provenance of the sequence in which they occur and may be predominantly carbonate, sedimentary, granitic or volcanic in composition.

Sandstones are variable in grain size, generally white, buff or gray in colour and contain bands of or isolated pebbles. Their degree of consolidation varies from friable to well cemented. Cross bedding is frequent. In addition to quartz, variable amounts of feldspar and micas are present in a silty or less commonly, a carbonate matrix. Many of the sandstones are probably of fluvial origin.

Siltstones are usually gray or buff in colour, of variable grain size. They may be massive or finely bedded and some appear to have loessic characteristics, including traces of plant rootlets. They may amount to tens of metres in thickness.

The degree of structural deformation varies from basin to basin and reflects recent post-depositional orogenic movements. In the south and west the Tertiary rocks appear to be consistently horizontal in attitude. Gentle folding has taken place in the Jalalabad basin, there have been two periods of movement in the Miocene at Bamyan and intense deformation has affected some of the Tertiary beds north of the Hindu Kush.

In the light of the criteria generally accepted for uranium favourability, the Tertiary successions appear to satisfy the lithological requirements, in that they consist of alternating fine and coarse clastic beds; the latter are frequently arkosic or feldspathic. However, most of them appear to lack the significant concentrations of fossilized organic (woody) material which seems to be a prerequisite for the segregation of commercially viable amounts of uranium. Although carbonaceous and argillaceous beds may show slight increases in radioactivity over what might be expected (Jalalabad, Faragad) this could well be due to uptake of uranium from ground or surface water with a normal content of the element. The only definite instance of sandstone with fossil carbonized wood (south of Sarobi) gave no anomalous readings.

The only Tertiary intramontane basins which seem to have fertile source rocks lying adjacent to them are those centred on Jalalabad and possibly in the Khanabad-Rustaq district north of the Hindu Kush. Others in the west of the North Afghan Platform, around Herat and in the south and south east of the country appear to lack the acid magmatic rocks with elevated uranium contents which seem to be necessary to provide the mobile uranium. Peneplanation of the source areas has not taken place. Tuffaceous sediments at Herat, Shindand and Ghazni are intermediate or basic in composition and exhibit no unusual radioactivity.

Closed basin environments or basins with restricted outflow appear to be fairly common. This feature occurs both at Jalalabad and Khanabad-Rustaq areas.

If relatively undisturbed sequences are considered to be favourable for uranium mineralization, those in the south, southwest and at Jalalabad would appear to be the most promising.

Panjshir-Bamyan Fault Zone

The four previously reported occurrences of uranium in Afghanistan - Surkh-e-Porsa, Gulbahar, Machtan and Sar-e-Sand - appear to have a close spatial relationship with the fault zone. It extends across Afghanistan trending southwest from the eastern frontier to the neighbourhood of Ghorband and thence to the Iranian border. In the area of interest the fault zone largely occupies the valleys of the Panjshir and Ghorband Rivers which are bordered north and south by the precipitous mountain ranges of the Hindu Kush and the Koh-i-Baba. Here, it is approximately 300 km. in length and up to 30-40 km. wide. The rocks affected by the fault zone range in age from Archaean to Tertiary.

The uranium occurrences appear to be somewhat varied in origin, arising from assimilation of slightly radioactive shale by acid igneous rock at Surkh-e-Porsa, from deposition in quartz veins (Machtan) and from segregation in a biotite-rich inclusion at a granulite contact with an unspecified rock type. Note has also been taken of the occurrence of radioactive springs in this zone.

3. PAST EXPLORATION

Much work was done on the geological survey of the country by various agencies after 1930 but, although Afghanistan is rich in minerals, its mountainous nature and its remoteness from the sea make the profitable exploitation of this source of wealth a matter of extreme difficulty.

The first occurrence of uranium (uraninite) in Afghanistan was reported in 1957 by the Afghan Geological Survey from a locality near the lapis lazuli mine at Sar-e-Sang in Badakhshan. Further discoveries followed by the Afghan Geological Survey, including Japanese geologists Sawata and Nakazawa, and by the French CEA Mission. These are situated at Surkh-e-Porsa, in the Ghorband region, and near Gulbahar and Marishtan (described in the literature as Machtan) in the Panjshir valley (Dwg. No. 1).

In April 1959 the French Commissariat à l'energie atomique, after a preliminary investigation in late 1958, sent a team of six people to carry out a prospecting campaign for uranium minerals. The team consisted of two geologists, three prospectors and one mechanic, which during the field season in 1959 carried out a reconnaissance survey based on the network of main roads using carborne equipment and prospecting equipment carried on horseback. Fifteen thousand kilometres of roads were surveyed with carborne equipment and about 2,000 kilometres were covered on horseback. Detailed prospecting by the French team along the accessible valley bottoms produced nothing else of immediate significance; geochemical sampling was done in some areas but reporting and analysis of the results is incomplete and those which have been properly documented do not refer to areas thought to be of interest by the writer. None of the previously known uranium showings in Afghanistan are of any economic significance, being far too small but, fortuitously or not, they all seem to be associated with the major fault zone running through the Ghorband and Panjshir valleys to the Sar-e-Sang area.

In 1974, at the request of the Government the I.A.E.A. provided expert assistance for a total six month period between October 1974 and June 1975. The expert undertook a preliminary evaluation mission of the uranium potential and advised the Government on future uranium exploration policy. A report (reference) was submitted to the Government in late 1975.

4. URANIUM OCCURRENCES AND RESOURCES

The following are brief descriptions of the four occurrences known prior to the IAEA mission of 1974-75.

1. Machtan (Marishtan)

This occurrence is situated about 1.5 km. above the confluence of the Hasarak and Panjshir Rivers at Rukha. It is as described by the C.E.A. Mission, outcropping on the face of a steep cliff overlooking the river. It consists of five narrow, steeply dipping, northnorthwest trending quartz filled fissures of variable width - up to 15 cm. Patchy readings up to 4,000 cps are encountered and a specimen from the most radioactive area gave 102 ppm U by chemical analysis.

2. Surkh-e-Porsa

A variety of occurrences of uranium and anomalous radioactivity occur on the east bank of the river between 5 and 6 km. south of the Surkh-e-Porsa Government offices.

1) The occurrence first reported by the Japanese geologists and revisited by the French C.E.A. Mission in the late 1950's is associated with shale or phyllite inclusions in a peneconcordant aplite sill in Upper Proterozoic country rocks consisting of limestone with small lenses of argillaceous material and rare streaks of pyrite several cm. long and several mm. thick.

Uranium is segregated just below the hanging wall of the sill over a lateral distance of 2 - 3 metres and a width not exceeding 0.5 m. There is a close association with inclusions of baked shale of the order of several cm. across and pyrite. Uranium contents up to 0.06 per cent are reported by I.A.E.A. chemical analysis.

Both Japanese and French reports mention detailed prospecting in the area, with no encouraging results.

3. Gulbahar

Early reports described this occurrence as "bands of low radioactivity in quartzites" no extension was found.

4. Sar-e-Sang

The uranium mineralisation here consists of uraninite mineralisation in a kidney shaped inclusion rich in biotite at the contact with a leptynite.

1974-75 I.A.E.A. Mission Findings

Tertiary Intramontane Basins

Jalalabad Basin

Three areas with anomalous uranium content have been delineated in sandstones of the Neogene Lataband Series in the Jalalabad Basin. They are situated west and south of Sarobi on the west end of the basin. A radiometric anomaly lacking uranium occurs midway between Sarobi and Jalalabad just south of the main road.

Neogene-Lower Pleistocene continental sediments of the Lataband series form an irregular basin measuring approximately 110 x 50 km. with the long axis trending south-southeast. The sedimentary rocks have been deposited in a framework of acid intrusions, gneisses, metamorphics and sediments ranging in age from probable Lower Proterozoic to Oligocene and are capped locally by a series of flat lying Middle Pleistocene to Recent sediments.

Acid igneous rocks which could furnish mobile uranium consist of gneissic or diversely foliated biotite- or muscovite- biotite gneisses, garnet-muscovite granulites and various biotite gneisses of Lower Proterozoic age.

The radioactivity of these granites is not exceptional and is usually between 150 and 200 cps.

Potential host rocks are represented by the Neogene-Lower Pleisticene Lataband Series which consists mainly of sandstones with subsidiary conglomerates and argillites.

The conglomerates are polymictic in composition with varying amounts of granitic pebbles and boulders.

The dominant lithological group in the sequence is sandstone. It is white gray or buff in colour, fine to medium grained, massive or bedded, cross bedded and often weakly consolidated or friable.

Anomalous radioactivity was first detected about 14 km. west of Sarobi south of the bitumen road and opposite the end of the Naghlo Dam. Three sandstone horizons, the topmost consisting of a small erosion remnant, show anomalous radioactivity; the occurrence of abnormal amounts of uranium in sandstone to 130 ppm has been confirmed by chemical analysis but no discrete uranium mineral has yet been seen. This zone has been traced for about 1.5 km. southward along the strike of the sandstone and is open ended in both directions.

The uranium bearing sandstones occur in the bottom part of the sandstone-siltstone sequence which is locally an estimated 100 m. thick.

The general background on sandstone here is 120 to 150 cps. On the uranium bearing areas this increases to 150 to 200 cps generally. High areas giving up to 400 cps are fairly scattered and count rates to 600 cps and over are rare. Selected specimens of the more radioactive material give uranium contents of 45, 103, 120 and 130 ppm. The radioactivity of the older conglomerate-siltstone-sandstone series is less than 120 cps.

A further showing of radioactivity occurs in a carbonate vein cutting sandstone about 650 m. south of the road. This fissure filling is 25 to 30 cm. thick. Maximum readings here are 1000-1600 cps. Uranium content is 560 ppm. This strongly confirms that the deposition of some, at least, of the uranium occurred after consolidation of the sandstones.

I.A.E.A. Laboratory reports that there is a deficiency in radium in some of the samples submitted. This could mean that the uranium has been transported comparatively recently to its present location and has not attained equilibrium.

Two radioactive sandstone localities were detected on the old Lataband Pass road. The more westerly one occurs again in sandstone (part of a sandstone-siltstone group in the basal conglomerate) with more resistant buff limonite cemented areas in a white friable variant. The usual background on the sandstone is 100 to 150 cps with some areas reaching about 600 cps.

Eight km. to the east there is a rather similar occurrence in sandstone, giving count rates to 450 cps and 66 ppm uranium. This was not followed out.

Midway between Sarobi and Jalalabad, anomalous radioactivity, lacking uranium occurs in sandstones on the south side of the road. Maximum count rate is 400 cps and it seems to be a spot high.

In the light of the generally accepted criteria for productive uraniferous sandstones, the essential features of these occurrences are:

(1) a suitable assemblage of probable fluvial sandstones, flat lying or gently folded, but not located in a cratonic zone;

(2) adjacent crystalline and magmatic rocks, but not located in a peneplaned region;

(3) no evidence of associated tuffaceous rocks;

(4) alternating siltstones and sandstones, the latter with moderate permeability;

(5) feldspathic rather than arkosic lithology but a sad lack of organic matter;

(6) a probable closed basin environment during and after the period of deposition.

In view of the occurrence of uranium in quantities far exceeding those in non mineralized sandstones, and the similarity in age, environment and appearance of the sandstones to those in the Siwaliks of Western Pakistan, a modest reconnaissance type exploration programme can be justified on these occurrences.

5. PRESENT STATUS OF EXPLORATION

At the termination of the IAEA expert's mission in mid 1975 he recommended in his report that three areas of Afghanistan should be the subject of further exploration work; these were 1. The Jalalabad Basin 2. the Panshir-Bamyan Fault Zone and 3. an area north of Baru. A U.N. consultant later endorsed these recommendations and suggested two other areas for consideration. On the basis of these reports the Afghanistan Ministry of Mines and Industry has been in negotiation with the U.N.D.P. office about the best means of financing and implementing these recommended programmes. A large scale U.N.D.P. project, a U.N. Revolving Fund for Mineral Resources project and direct bi-lateral aid have all been discussed but no actual project agreed up to the end of 1976. No national programme has been in effect since the end of the IAEA expert's mission in mid-1975.

6. POTENTIAL FOR NEW DISCOVERIES

The potential for new discoveries in Afghanistan is very difficult to assess as the total uranium exploration effort to date is very small. All the previous work outlined in this report has, in fact, only covered an extremely small part of the country. The total area selected by the I.A.E.A. expert as favourable for further reconnaissance exploration amounts to 20,000 km^2 including 3000 km^2 in the Jalalabad Basin. The only comparison with similar areas that can be made is between the Neogene formations of the Jalalabad Basin and the Siwalik, middle Miocene rocks of the Dera Ghazi Khan area of Pakistan. There are indeed many lithological and structural similarities and if a comparison is made the Jalalabad Basin may have a Speculative Potential of some hundreds of tonnes U_3O_8 - say 1000 tonnes.

The other areas are more difficult to assess but a further Speculative Potential of 1000 tonnes U_3O_8 might be considered, making a total of 2000 tonnes U_3O_8 on present evidence.

J. Cameron
Vienna, 1976

Category 2. 1,000 - 10,000

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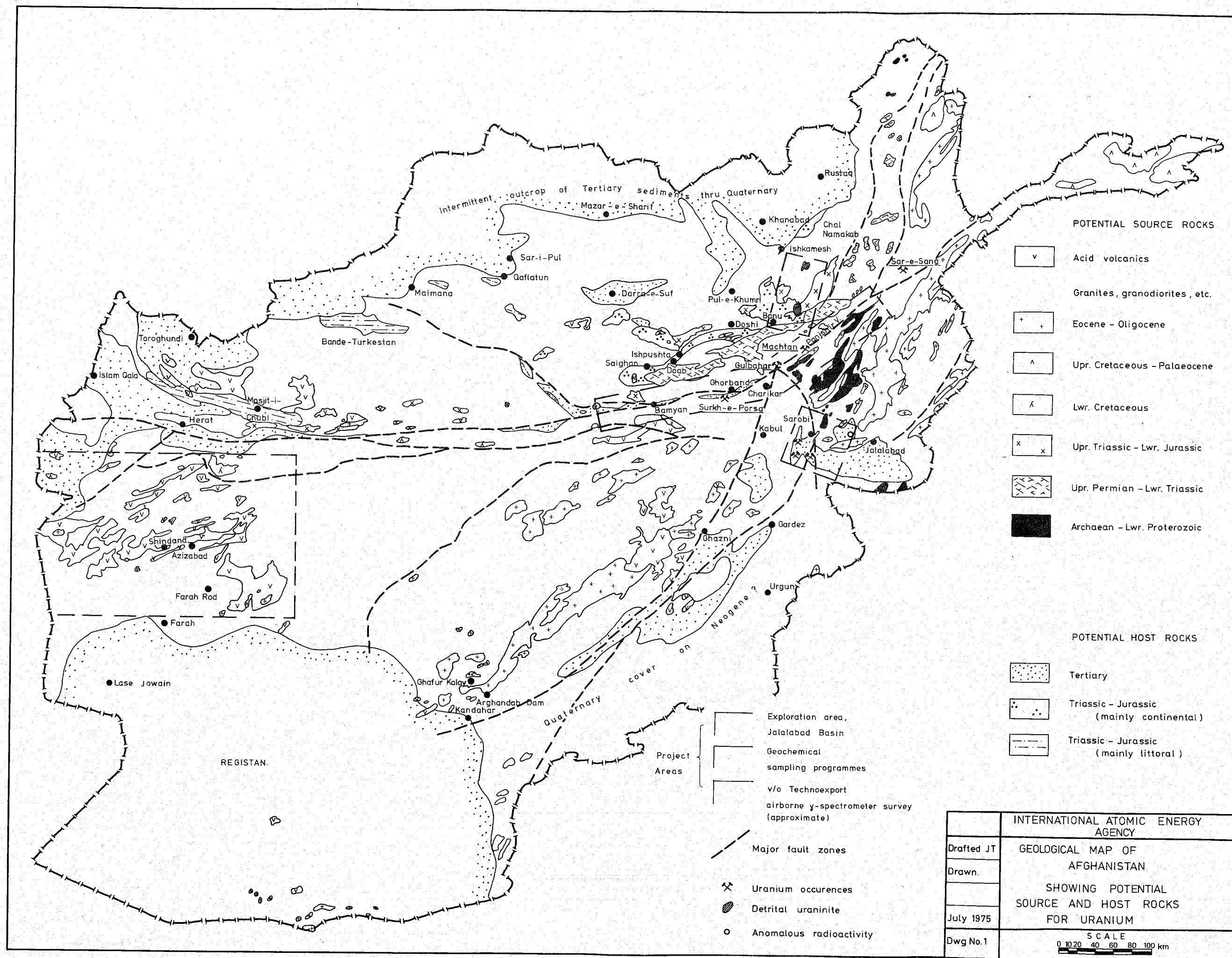

	INTERNATIONAL ATOMIC ENERGY AGENCY
Drafted JT	GEOLOGICAL MAP OF AFGHANISTAN
Drawn.	
	SHOWING POTENTIAL SOURCE AND HOST ROCKS FOR URANIUM
July 1975	
Dwg No. 1	SCALE 0 10 20 40 60 80 100 km