

**GOVERNMENT OF PAKISTAN
GEOLOGICAL SURVEY OF PAKISTAN**

Information Release No. 33



**RECONNAISSANCE FOR RADIOACTIVE MINERALS IN
DARDISTAN, BALTISTAN AND HARAMOSH IN GILGIT
AGENCY, WEST PAKISTAN.**

**By
R. A. Khan Tahirkheli**

**Issued by the Director General, Geological Survey of Pakistan,
Quetta.**

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Figure 1 - Geological and radiometric map of traverse-route in Gilgit Agency, West Pakistan.

ABSTRACT

The eastern and north eastern parts of the Gilgit Agency which constitute Baltistan, Dardistan and Haramosh were reconnoitred for radioactive minerals during the period of July-October 1960.

A geological map of the traverse-route was prepared and radioactivity of the rocks exposed was plotted thereon. Samples of sand were collected from the tributaries of Indus river for radiometric and mineralogical study.

The radioactivity in the gneissic bands in metasediments measured between 0.035 and 0.07 mR/hr. Some of the granite intrusions and acid dykes of later phases read 0.03 to 0.07 mR/hr. Few sand samples from the tributaries of the Indus yielded relatively high radioactivity, pointing the possibility of uranium mineralization in their catchment areas.

These favourable indications of possible mineralization warrant an expeditious programme for having a thorough radiometric check in this area.

INTRODUCTION

Purpose and scope of the report

A reconnaissance for radioactive minerals in Gilgit Agency was made during the period of July to October, 1960. The purpose of this investigation was to locate significant radioactive anomalies and to determine the advisability of more detailed study. In addition, the discovery of uraninite in the Indus alluvium, between Attock and Amb (Danilchik and Tahirkheli 1959, Tahirkheli 1959) necessitated further geological investigation in the upper reaches of the Indus to locate the source of this mineral.

The radioactive mineral exploration was conducted along the main tributaries of the Indus and covered a wide tract in Dardistan, Baltistan and Haramosh in the north eastern part of the Gilgit Agency. A geological map of the traverse route was prepared and radioactivity of the rocks exposed was plotted on this map. Samples of sand were also collected from the main tributaries and their side nalas with large catchment areas, for radiometric and mineralogical assays.

This report is an attempt to describe the geology of the area traversed and to give the results of radiometric traverses. Results of radiometric and mineralogical studies of sand samples in the laboratory have also been included in this report.

Location and accessibility

The area covered, constitutes the eastern and north eastern part of Gilgit Agency which is situated in the north western frontier region of West Pakistan.

Gilgit and Skardu are connected with Rawalpindi by a freighter service which runs six times a week, in fair weather. A fair weather jeepable road connects Gilgit with Balakot in Hazara district via Kaghan Valley which is plyable for three months from July to October, when the snow melts away. This road becomes occasionally impassable even during July-October due to rainfall or land slides.

Previous work

Very little geological work has been carried out in this remote part of the Gilgit Agency. Only a few reconnaissance traverses have been made along the major valleys. Among the earlier geologists, who surveyed this part of Gilgit Agency, the names of Lydekhari (1881), Wadia (1928, 1937) and Auden (1933) of the Geological Survey of India may be mentioned. Abu Bakr of Geological Survey of Pakistan covered part of this area in 1950 and results of his investigation are available in his un-published report.

Acknowledgements

The author takes this opportunity to thank the Political Agent, Gilgit, the Additional Political Agent, Skardu, and the Assistant Political Agents of Astore and Skardu for their cooperation and help during his stay in this area. Aziz Ahmed Khan from Geochemical Branch helped in conducting radiometric analysis of the sand samples.

GEOGRAPHY

The area under study lies within the Higher Himalayan region of the Trans-Himalayan system. The mountains are uninhabited and possess an exceedingly high relief. The higher summits vary from 16,000 to 26,620 feet above sea level. The most prominent peaks in the region are Nanga Parbat (26,620 feet) and Sassi Sanyari (24,270 feet) in Dardistan and Haramosh respectively. K2 (28,250 feet), Goshierbrum (26,470 feet) and Mesherbrum (25,660 feet) are situated a short distance outside the region.

At high altitude the ranges are snow covered and glaciated. Some of the biggest glaciers of the Himalaya e.g. Baltoro, Siachen, Biafo and Hispar lie within a range of 10 to 50 miles from the region. Shigar valley in Baltistan serves as a gateway to these glaciers and some of the high peaks mentioned above.

Sharp topographical features with whittled peaks are the relics of the past glacial activities in the area. These sharp peaks are separated by broad glacial troughs which have a low gradient. The valleys are broad with characteristic cirques and small hanging valleys. The valley floor and the hill-slopes are usually concealed under a mantle of morain deposits. Fresh debris are continually added by avalanches, which sometimes expose the bedrock geology of snow-covered and unapproachable places.

The Indus with its numerous tributaries forms the main drainage artery of the region. The tributaries drain the meltwater of the glaciers. In Baltistan the three tributary rivers are Shigar, Shyok and Oldhing. The Astor river joining the Indus downstream of Bunji

drains the ice melts of Dardistan. Besides, numerous perennial side-streams, with headwaters in perpetual ice, join the Indus during its long course in this region.

GEOLOGY

The rock types mostly met with in this region are meta-sediments intruded by granodiorite and granite. A number of later dykes of aplite, pegmatites, granite, diorite and dolerite are found injected in these rocks.

Meta-sediments

Meta-sediments are found to cover greater portion of the Indus Valley in Haramosh and upstream of Skardu. In Shigar Valley these rocks continue upstream beyond the confluence of Basha and Braldu rivers. In Astor valley, these rocks are exposed for twelve miles between Doian village and a point about six miles downstream of Astor.

The general strike of the meta-sediments in Astor valley is northwest. The Astor river flows along the axial plain of an eroded anticline of these rocks. In Haramosh, downstream of Skardu along the Indus river, the strike is north and north east and the river flows transverse to the strike. In Shigar Valley except a few local changes in the dip due to minor foldings, the general strike direction is north and north east and conforms to that of Haramosh Range.

Meta-sediments consist of almost completely metamorphosed rocks belonging to more than one geological formation. In most cases it has not been possible to differentiate these formations as their original relationship have been obliterated by the intense metamorphism and tectonic disturbances.

The rock types are schist, quartzite, gneisse and re-crystallized limestone with thin cherty bands. A large number of Quartz veins are also present. In the areas of mild metamorphism the sedimentary rocks still retain the original sedimentary characters and in such localities they are coloured shale, slate and white and grey limestone. These rocks are ferruginous at places and wather to rusty brown colour.

Granodiorite

Granodiorite covers wide stretches in Astor valley in Dardistan and most of the low scattered hillocks in Deosai plain are composed of this rock. In Baltistan granodiorite is exposed between Tolti and Baghicha along the Indus Valley upstream of Skardu. Granodiorite is more extensive in occurrence in Haramosh ranges downstream of Sassi and is the continuation of Dardistan granodiorite.

Among the earlier workers Lydekker and Wadia discussed granodiorite of Astor and Manga Parbat in detail and termed this rock as biotite-gneiss. The most recent work on granodiorite of Gilgit Agency is that of Ivanac, Traves and King (1956). Their work was mostly confined to the north and north-west parts of Gilgit Agency. Toward northeast, they covered Indus valley upto Sassi in Haramosh. They mapped three parallel-trending granodiorite batholiths and named them Karakoram, Darkot Pass and Ladakh granodiorite after the prominent ranges where they occur.

The granodiorite of these intrusive bodies is pale to dark grey, medium grained, generally foliated and variable in composition. Epidotisation in granodiorite is well marked at places. Its contacts

with the country rocks are sharp and little alteration of the country rocks due to contact metamorphism has been marked.

Granite, Granite-Gneiss

Granite occurs largely along the summit of the mountains and most of the high peaks in the area consist of this rock. Various common types of granite met with in this area are hornblende-granite, muscovite-granite, biotite-granite and porphyritic-granite. Boulders of micro-granite have also been noticed in Sokoro, Daltambore and Alchori nalas along the right bank of Shigar valley, upstream of Shigar village. Acid and basic intrusives have frequently injected these rocks. Foliation has been imparted in most of the granites converting them into granite gneiss.

A series of parallel dolerite dykes are intruded in the granite-gneiss near Gol and Oldhing in the Indus Valley, upstream of Skardu. The contacts are sharp and well marked which create an effect of alternating sheets of granite gneiss and dolerite. Foliation in the gneiss is parallel to the general strike of the country rocks.

The field relations and other characters of the granitic intrusions suggest that they belong to at least three different phases of igneous activity.

Dykes

The last phase of the igneous activity in the region is marked by the intrusion of acid, basic and intermediate dykes. Acid dykes consisting of aplite, pegmatite and younger granite are numerous and are younger in age than dolerite and diorite. Pegmatite dykes or veins are

usually thin but a few thick ones also occur in the region. Around Dassu in Braldu valley, about two miles upstream of its confluence with the Basha river, there are a number of scattered quartz pegmatite veins, varying in thickness from two to six feet. Some of these veins are mineralised and were worked during pre-Independence days for aqua marine and industrial beryl.

RADIOMETRIC RECONNAISSANCE

Radioactivity of the rock outcrops along the traverse-route was measured by LaRoe type hand-borne scintillation counter. The results of radiometric traverse were plotted on quarter inch topographical sheets of Survey of Pakistan in order to demarcate areas, favourable for the occurrence of radioactive minerals. The structural and intrusive detail of those rocks along the traverse routes was examined.

The background radioactivity in this region varies from place to place. In granodiorite area, background was considerably low, ranging between 0.002 to 0.005 mR/hr, average background being 0.003 mR/hr. In granitic areas background ranged from 0.008 to 0.015 mR/hr. The areas of Meta-sediments gave 0.0080 to 0.010 mR/hr as a background. Background was substantially high at those places where acid dykes intruded these rocks.

Radiometric traverse along Astor river

Radiometric traverse in Dardistan was conducted along Astore river upto several miles beyond the confluence of its two principal tributaries upstream of Astor. Eastern slopes of Nanga Parbat around Rampur and Harmeobas was covered. Radioactivity in meta-sediments, exposed in Astor river valley measured 0.020 to 0.045 mR/hr; various types of schists gave

a reading of 0.02 to 0.025 mR/hr whereas gneisses measured 0.020 to 0.045 mR/hr. The granodiorite exposures along the route read 0.0020 to 0.010 mR/hr. High radiation was confined around the aplite and pegmatite dykes in the granodiorite areas. Hornblende granite intrusive exposed in the ridge north of Chelum about a mile upstream of its confluence with Sardar Kothi gah measured 0.025 to 0.07 mR/hr. Some of the granite boulders erratically distributed over the southern slope of this ridge read 0.025 to 0.0450 mR/hr. A few aplite, pegmatite and younger granite dykes encountered along the route gave 0.020 to 0.035 mR/hr.

Granodiorite intrusive, exposed in low hillocks on Deosai plain measured 0.004 to 0.008 mR/hr and the small granite intrusive near Burji-la gave 0.025 to 0.035 mR/hr. The meta-sediments south of Skardu measured 0.025 mR/hr.

Radiometric traverse along the Indus
upstream of Skardu

Radiometric traverse upstream of Skardu was conducted along the Indus river upto Oldhing.

The radioactivity in meta-sediments measured 0.02 to 0.025 mR/hr. The coarse grained granite north of Gol village gave 0.015 to 0.025 mR/hr. The dolerite dykes injecting granite gneiss south of Gol, measured less than 0.01 mR/hr. Granodiorite near Baghicha read 0.005 to 0.010 mR/hr, whereas younger granite intrusives in these granodiorite measured 0.01 to 0.020 mR/hr. About six miles upstream of Baghicha, near Shirting, and Tarkuti, granite gneiss measured 0.03 to 0.035 mR/hr.

Along Oldhing river 3 miles upstream of its confluence with the Indus River granite boulders transported by Bamachah nala emitted high radiation, measuring 0.04 mR/hr. All the meta-sediments exposures, encountered along this route measured 0.02 mR/hr.

Radiometric traverse along Shigar river

The meta-sediments exposed along the left bank of Shigar river measured 0.02 to 0.03 mR/hr. Micro-granite gneiss boulders found in Sokoro, Daltambore and Alchori nalas, read 0.035 mR/hr.

The Meta-sediments exposed between Dogoro in Basha valley and Dassu in Braldu valley, upstream of the confluence with Basha river, are composed of light to dark coloured gneisses and schists. Radioactivity in these beds is appreciably high - with some bands of gneisses measuring 0.040 to 0.070 mR/hr. The schistos rocks, usually give 0.020 to 0.030 mR/hr. These beds are frequently injected by acid dykes. A few pegmatite dykes around Dassu emitted radiation between 0.04 to 0.07 mR/hr.

In Basha river valley, these meta-sediments extend upstream along the left bank of the river, and radioactivity from these beds varies from 0.025 to 0.045 mR/hr. Around Dogoro, granite gave 0.015 to 0.025 mR/hr.

Consistant radiometric check on the alluvium of Shigar river and its tributaries, revealed gradual increase in radioactivity towards upstream. Near Shigar village, river alluvium measured 0.015 mR/hr. About a mile downstream of the confluence of Basha and Braldu, radioactivity was 0.02 mR/hr. In Braldu and Basha rivers radiation was higher and measured between 0.02 and 0.03 mR/hr. In general radioactivity from alluvium of Basha river was slightly higher than that of Braldu river.

Laboratory results of sand samples will be given in the sequel.

Radiometric traverse along the Indus
downstream of Skardu

During this traverse, most of the area of Haramosh Range, along the Indus river, was radiometrically surveyed. All the side nalas from Haramosh range joining the Indus were sampled.

The meta-sediments exposed along the right bank of the Indus measured between 0.02 to 0.03 mR/hr. Granite intrusives exposed near Dassu and Rondu read between 0.015 to 0.030 mR/hr. Granodiorite intrusives downstream of Rondu and Sassi, gave between 0.004 and 0.01 mR/hr.

In general Radioactivity was low in Haramosh Range between Skardu and Gilgit except in a few bands of gneiss between Shingus and Sassi.

LABORATORY WORK

Preparation of samples

The sand samples collected from the streams were radio-metrically and mineralogically assayed in the laboratory. Sample for laboratory work was obtained from each **field** sample by adopting simple method of quarter and coning by hand. Test sample, thus obtained, was split into two parts; one third from each final sample was kept **for radiometric** analysis and the rest for mineralogical studies. Each test sample meant for radiometric assay, was examined in the scaler counter. Some of the samples giving high counts were picked up for mineralogical studies.

All such sample selected for mineralogical studies were hand-panned in the laboratory to remove the low gravity minerals such as micas, quartz, feldspars. Magnetite from each concentrate was removed by horse-shoe magnet.

The magnetite-free concentrates were studied under ultra-violet lamp of short wave length for fluorescent minerals.

For grade analysis, I.M.M. Seive Scale was employed. Microscopic slides were prepared from magnetite-free concentrate and its seive fraction of - 150 mesh.

Radiometric analysis of sand samples

Indus Valley, upstream of Skardu

Sample No.	<u>o/o U_3O_8</u>	<u>Error</u>	<u>Location of the samples shown in the attached map.</u>
1. 111	0.0210	+ 0.002	
2. 112	0.0165	+ 0.002	
3. 113	0.0450	+ 0.003	
4. 114	0.0030	+ 0.001	
5. 115	0.0035	+ 0.001	
6. 116	Trace	-	
7. 117	Trace	-	
8. 118	0.0175	+ 0.002	
9. 119	0.0115	+ 0.002	
10. 120	0.0030	+ 0.001	
11. 121	0.0085	+ 0.001	
12. 122	Trace	-	
13. 123	0.0020	+ 0.0007	
14. 124	Trace	-	
15. 125	0.0015	+ 0.0006	

Indus Valley, downstream of Skardu

16. 126	Trace	-	
17. 127	0.0025	+ 0.0007	
18. 128	0.0015	+ 0.0006	
19. 129	0.0015	+ 0.0006	
20. 130	0.0075	+ 0.0013	
21. 131	0.0005	+ 0.0003	
22. 132	0.0085	+ 0.0014	

Indus Valley, downstream of Skardu

23. 133	0.0050	+ 0.0011
24. 134	0.0050	+ 0.0011
25. 135	0.0255	+ 0.0024
26. 136	0.0045	+ 0.0010
27. 13717	0.0010	+ 0.0005
28. 138	0.0015	+ 0.0006

Astor Valley

<u>Sample No.</u>	<u>% U₃O₈</u>	<u>Error</u>	<u>Location of the samples in the attached map.</u>
29. 139	0.0015	+ 0.0006	
30. 140	0.0145	+ 0.0018	
31. 141	0.0140	+ 0.0018	
32. 142	0.0050	+ 0.0011	
33. 143	Trace	-	
34. 144	Trace	-	

Shigar Valley and upstream

35. 145	Trace	-
36. 146	0.0025	+ 0.001
37. 147	Trace	-
38. 148	0.0130	+ 0.002
39. 149	Trace	-
40. 150	0.0055	+ 0.001
41. 151	0.0620	+ 0.004
42. 152	0.0065	+ 0.001
43. 153	0.0115	+ 0.002
44. 154	Trace	-

MICROSCOPIC EXAMINATION OF CONCENTRATED SAND

MINERALS	Sample No.135		Sample No.132		Sample No.130		Sample No.140		Sample No.115		Sample No. D 1		REMARKS
	Conc	-150mesh	Conc	-150mesh	Conc	-150mesh	Conc	-150mesh	Conc	-150mesh	Conc	-150 mesh	
1. Magnetite	S	S	C	S	S	S	V.C	C	C	S	C	S	Frequency scale by Evans, Hyman and Majeed (Krumbein and Pettijohn, 1938) is adopted, which is as follows:- 80% very abundant (VA) 40% Abundant (A) 20% Fairly abundant (F.A.) 10% very common (V.C.) 5% common (C) 1-2% scarce (S) 1% Rare (R)
2. Garnet	C	C	F.A.	V.C.	A	A	C	C	C	S	F.A.	V.C	
3. Zircon	C	V.C	C	V.C	C	V.C	C	V.C	S	C	C	V.C	
4. Opaque minerals.	C	C	C	S	C	C	F.A.	F.A	S	R	C	V.C	
5. Pyroxene & Amphibole.	C	C	V.C	C	S	S	V.C.	C	V.C.	V.C.	C	C	
6. Apatite	S	S	R	R	S	R	S	S	S	C	R	S	
7. Tourmaline	S	S	R	R	S	S	S	S	S	S	R	S	
8. Uraninite	R	R	Nil	R?	R?	R?	Nil	R?	Nil	Nil	S?	S	
9. Monazite	R	R	R	R	R	R	R	R	R	R	R	S	
10. Rutile	R	Nil	R	Nil	S	S	R	Nil	R	Nil	R		

* Sample D 1 is goldwasher's concentrate from Basha river.

CONCLUSIONS

A. (1) Gneiss bands in meta-sediments in Astor Vally near Doian, in Braldu valley near Dassu and in the Indus valley between Shingus and Sassi measured 0.035 to 0.070 mR/hr.

B. Among granite intrusions which were radiometrically checked, granite and granite-gneiss of the following localities gave encouraging results:

(1) Shirting, Tarkuti, along Bamachan nala near Oldhing, in the Indus valley upstream of Skardu.

(2) Micro-granite gneiss boulders in Alchori, Daltambore and Sokoro nalas in Shigar valley about five miles upstream of Shigar.

(3) Granite intrusive near Chelum Chauki.

(Radioactivity in these granite and granite-gneiss measured 0.035 to 0.07 mR/hr.)

C. (1) Numerous aplite, pegmatite and younger granite dykes which represent the latest phase of acid intrusive gave radioactivity ranging from 0.03 to 0.07 mR/hr.

D. (1) Some of the sand samples collected from various nalas gave relatively high radioactivity, indicating possible favourable mineralization in their catchment areas (see Fig. 1).

E. (1) Under ultraviolet lamp of short wave length, rock samples which showed anomalies, were found to contain disseminated grains, fluorescing to yellow and yellowish green colours. A few concentrates of sands samples fluoresce to yellow colour.

RECOMMENDATIONS

Reconnaissance for radioactive minerals in Gilgit Agency was made on a regional basis rather than the study of selected areas. The structural features of the country rocks and the numerous intrusions make this region favourable for the occurrence of radioactive minerals.

From the survey it has been noted that radioactivity exist in meta-sediments which in general measures 0.01 mR/hr, more than the background. Gneissic bands in these formations near Shingus, Dassu and in Astor valley read 0.035 to 0.070 mR/hr. A detailed examination of these rock formations will be useful to locate more favourable areas where enrichment of radioactive minerals may be higher than the present indications.

A few granite intrusives, as discussed before, read 0.035 to 0.070 mR/hr. Similarly some dykes of aplite, younger granite and pegmatite which represent the latest acid intrusive phase, gave relatively high radioactivity. These anomalies, although of small nature in igneous rocks, cannot be overlooked at this stage when the bulk of the area infested with numerous igneous intrusives has not been examined. A very detailed and close examination of each igneous intrusive body, specially along its contact with the country rock is necessary to locate any mineralised zone.

Some of the rivers of this region contain gold and uraninite in their alluvium and deserve close attention. Alluvium of Basha and Braldu, tributaries of Shigar river may be cited here, where goldwashing is still practiced. Radiometric investigation extended upstream along the tributaries revealed an increase in radioactivity and the uraninite

crystals have been tentatively recognised under microscope in gold-washer's concentrate. Systematic sampling of the river alluvium and their tributaries will be helpful in locating any rich placers which ultimately may help in locating the source rock of this mineral.

Samples of sands collected from various nalas helped in locating favourable areas for the search of radioactive minerals. In some of the sands, besides monazite, crystals of uraninite have also been recognised. The area with substantial anomalies will help in future planning of radioactive mineral exploration in this region and if successful. This method will be adopted as a guide in exploring the virgin areas of Higher Himalaya where steep slope and sharp topographical features forbid easy scouting for radiometric survey.

Since very little geological mapping of the area had been done, a thorough geological investigation is necessary to prepare a base map for selecting favourable areas. The geological environment for uranium mineralization in the area studied, is favourable and warrant a planned programme for a thorough check for radioactive minerals.

P...../17.

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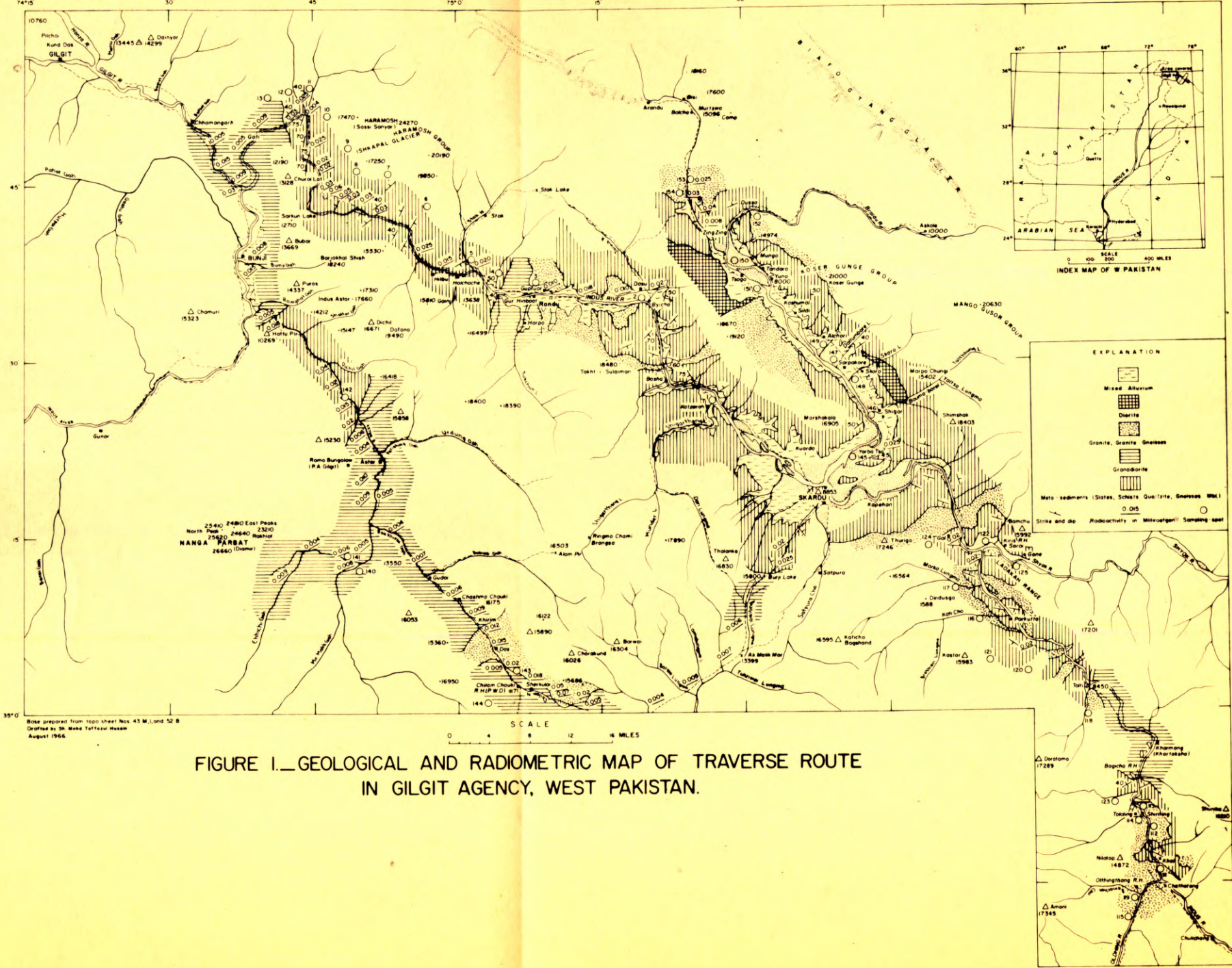


FIGURE I.—GEOLOGICAL AND RADIOMETRIC MAP OF TRAVERSE ROUTE
 IN GILGIT AGENCY, WEST PAKISTAN.