

U. S. Geological Survey.

REPORTS-OPEN FILE SERIES, No. 75-165. 1975.

U. S. GEOLOGICAL SURVEY
RESTON, VA.

(200)
R29o
no. 75-165



(200)
R290
no. 75-165



PK-12

UNITED STATES
(DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY. [Reports - Open file]

PROJECT REPORT
Pakistan Investigations
(IR)PK-12

TM
cm (IR)PK
cm OF

GEOCHEMICAL PROSPECTING FOR SOLUBLE SALTS IN

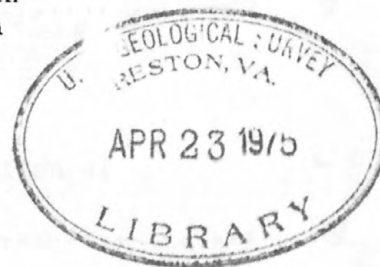
KUCHAKKI HAMUN, CHAGAI DISTRICT, PAKISTAN

By

S. Anthony Stanin 1022
U. S. Geological Survey

and

M. A. Wahid and Aziz Ahmad Khan
Geological Survey of Pakistan



OPEN FILE REPORT 75-165

This report is preliminary and
has not been edited or reviewed for
conformity with Geological Survey
standards or nomenclature

259173

Prepared under the auspices of the
Government of Pakistan and the
Agency for International Development
U. S. Department of State

CONTENTS

	<u>Page</u>
Abstract	3
Introduction	4
Purpose and scope of the investigation	4
Previous investigations	4
Regional setting	5
Sampling and analysis	6
Dispersion of soluble salts	7
Boron	7
Magnesium and potassium	7
Nitrates	7
Sulfates	8
Summary	8
References	9

ILLUSTRATIONS

Figure 1. Index map of Pakistan showing the location of Kuchakki hamun, Chagai District	4A
2. Geochemical map showing the relative dispersion of boron in samples of surface soil and surface alluvium in Kuchakki hamun	7A
3. Geochemical map showing the relative dispersion of magnesium and potassium in samples of surface soil and surface alluvium in Kuchakki hamun	7B

CONTENTS

Page

ILLUSTRATIONS

Figure 4. Geochemical map showing the relative dispersion of nitrates in samples of surface soil and surface alluvium in Kuchakki hamun	70
5. Geochemical map showing the relative dispersion of sulfates in samples of surface soil and surface alluvium in Kuchakki hamun	8A

GEOCHEMICAL PROSPECTING FOR SOLUBLE SALTS IN
KUCHAKKI HAMUN, CHAGAI DISTRICT, PAKISTAN

by

S. Anthony Stanin
U. S. Geological Survey

and

M. A. Wahid and Aziz Ahmad Khan
Geological Survey of Pakistan

ABSTRACT

The surface soil consisting of clay, silt, sand, and salt crust in Kuchakki hamun (dry lake) contains nitrates, sulfates, salts of boron, magnesium, and widely dispersed traces of potassium. No bromine or iodine salts were detected. Several hundred samples of soil were analyzed by spot-test methods, and the results were given comparative weighted-qualitative values. Isohaline-type geochemical maps, based on weighted-qualitative values, were prepared to show the dispersion patterns of boron, magnesium, potassium, nitrates, and sulfates in Kuchakki hamun. Boron and magnesium salts are concentrated in the southern and southeastern part of the hamun. Nitrates and sulfates are more widely distributed and have higher concentrations in the central area of Kuchakki hamun. More detailed qualitative work and quantitative studies on material collected in Kuchakki hamun are required to appraise the reliability of applied field methods and preliminary analytical data, and to determine the presence, abundance, and grade of economically important salts.

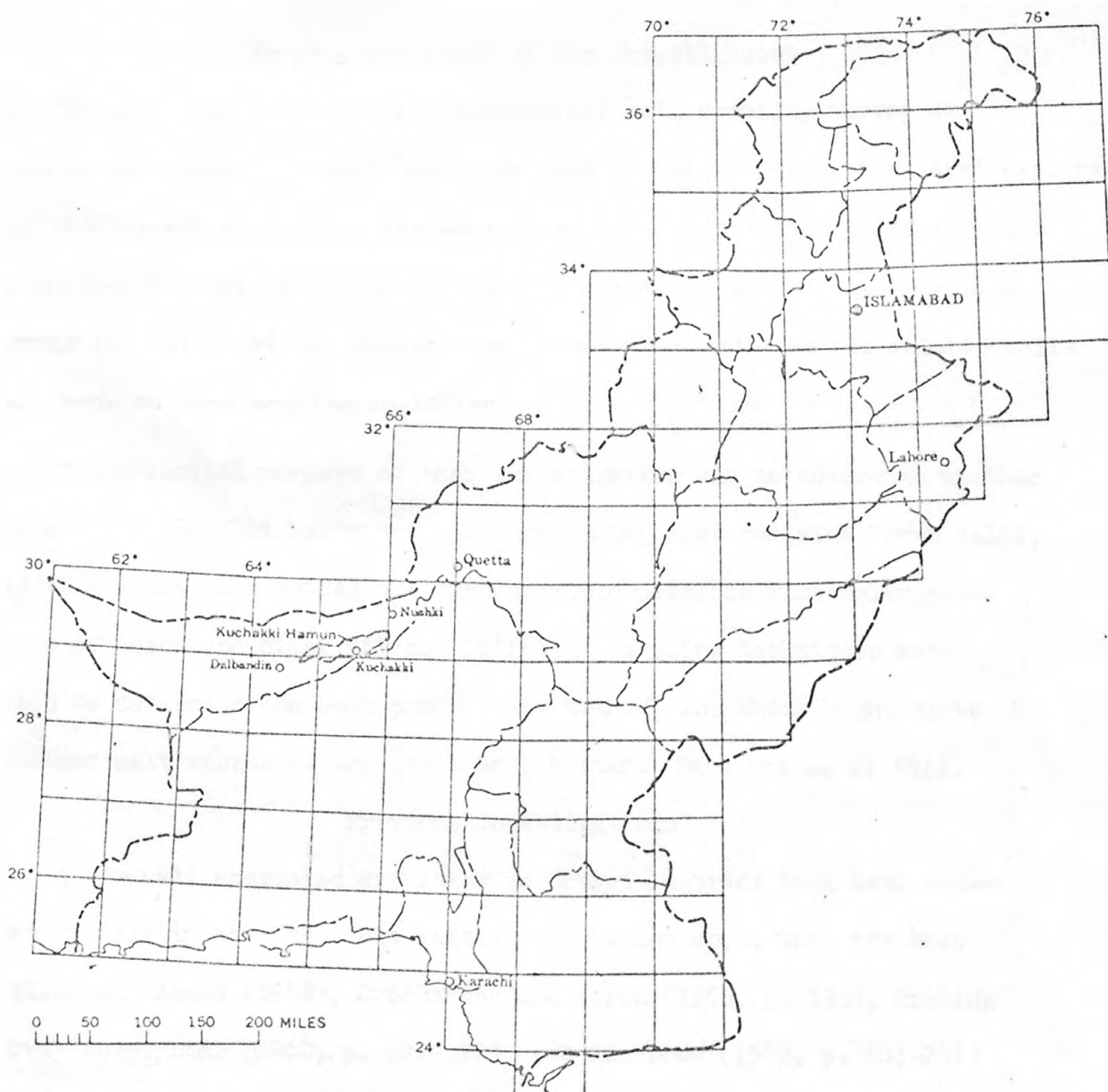


Figure 1. Index map of Pakistan showing the location of Kuchakki Hamun, Chagai District.

INTRODUCTION

The Kuchakki hamun (inland dry lake)(fig. 1) is located about one hundred miles southwest of Quetta, Pakistan, and is one of several large salt pans in the arid region of Chagai District. The hamun is about 37 miles long, about 8 miles wide, and lies north of the village of Kuchakki (between lat $29^{\circ}01'$ N. and $29^{\circ}13'$ N. and long $65^{\circ}03'$ E. and $65^{\circ}40'$ E.).

Purpose and scope of the investigation

In March and April 1964, a geochemical soil sampling survey was made in and around Kuchakki hamun, as part of the cooperative Mineral Exploration and Development Program of the Geological Survey of Pakistan and the U. S. Geological Survey, sponsored by the Government of Pakistan and the U. S. Agency for International Development. Spot-test analyses for soluble salts were made on soil samples collected.

The principal purpose of this investigation was to determine whether the soil in Kuchakki hamun and the surrounding area contains boron salts, and if surface geochemical exploration would disclose dispersion patterns of boron and other salts. Different sampling techniques were tried to determine the best prospecting method, one which might serve in other salt encrusted dry lakes in Pakistan. Data are as of 1966.

Previous investigations

A few salt encrusted dry lakes in Chagai District have been examined briefly in the past, but little information about them has been published. Ahmad (1948), Crookshank and Heron (1954, p. 133), Hunting Survey Corp., Ltd. (1960, p. 491-492), and Richards (1962, p. 267-269) briefly described some of the general features of a few dry lakes in Chagai District.

In 1962, the Geological Survey of Pakistan made seismic refraction measurements in Kuchakki hamun (Farah and Ahmad, 1962) and drilled a test well to a depth of 118 feet in Hamun-i-Lora hamun, about 10 miles to the northwest. The cores and brines from Hamun-i-Lora well contained sulfates, nitrates, salts of magnesium, and traces of boron (analytical laboratory file, Geol. Survey Pakistan). The discovery of traces of boron stimulated interest in geochemical investigation of boron and other salts in Kuchakki hamun.

REGIONAL SETTING

Kuchakki hamun is along the southern margin of the Dalbandin synclinalorium (Hunting Survey Corp., Ltd., 1960, p. 348). A belt of low, rounded hills composed of shale, sandstone, conglomerate, clay, limestone, and lesser amounts of volcanic rock borders the hamun on the north. These rocks range from Paleocene to Oligocene in age and represent the Pishi group^{1/} and Rakhshani Formation (Hunting Survey Corp., Ltd., 1960, p. 242-246, p. 248-253). The rugged mountain front of the Ras Koh Range overlooks the Kuchakki hamun from the south. Volcanic agglomerate, lava, tuff, and lesser amounts of limestone, tuffaceous shale, and sandstone crop out along the northern front of the Ras Koh Range. These rocks are believed to be Cretaceous in age and make up the Kuchakki Volcanic Group (Hunting Survey Corp., Ltd., 1960, p. 182-184).

^{1/}Stratigraphic names used in this report are formal names that have been used in published reports; status with respect to the Stratigraphic Code of Pakistan is currently (1965) under examination.

Early Recent gravel detritus forms the slope along the foot of the Ras Koh Range. Recent clay, silt, sand, and salt encrustation form the surface of Kuchakki hamun, which occasionally is partly covered by a shallow lake. Several island-like hills of the Kuchakki volcanic group protrude through the hamun surface in the southern and southeastern part of the area. Sand dunes and thick deposits of eolian sand cover large areas adjacent to the hamun.

SAMPLING AND ANALYSIS

A total of 350 samples of surface soil and surface alluvium were collected at half-mile intervals along 40 north-south traverses, spaced about 1 mile apart. The samples were prepared and analyzed qualitatively in the laboratory of the Geological Survey of Pakistan at Quetta.

Boron, bromine, iodine, magnesium, nitrate, potassium, and sulfate determinations were made on 342 samples by spot-test methods. The availability of chemical reagents and testing apparatus governed the analytical methods used. Boron determinations were made with quinalizarin (British Drug Houses, Ltd., 1949, p. 140); bromine was determined by using fluorescein (Feigl, 1958, p. 263); iodine by using starch and potassium nitrite (Feigl, 1958, p. 266); magnesium by using quinalizarin (Feigl, 1958, p. 224); nitrate by using brucine (Feigl, 1958, p. 328); and potassium by using sodium cobaltinitrite (Feigl, 1958, p. 230). Sulfate determinations were made by using the standard barium chlorite method (Snell and Biffen, 1944, p. 157). Bromine and iodine were not found in any of the samples from Kuchakki hamun.

The intensity of color or the amount of precipitate of samples yielding positive results were compared visually to establish weighted-

qualitative values that would show the relative concentration of a tested salt in each sample. Values were arbitrarily selected to represent increasingly higher salt content in samples containing more than trace amounts. These values were used to prepare isohaline-type geochemical maps that show the dispersion patterns of boron, magnesium, potassium, nitrates, and sulfates in Kuchakki hamun. The maps show the relative qualitative measurement of a specific salt in each sample; the maps do not compare the relative amount of one salt to another.

DISPERSION OF SOLUBLE SALTS

Boron

The dispersion pattern of boron (fig. 2) shows the major concentration of boron salts in the southeastern part of Kuchakki hamun. The boron apparently derives from rocks of the Ras Koh Range and is brought into the hamun by inflowing intermittent streams.

Magnesium and potassium

The dispersion pattern of magnesium (fig. 3) shows that salts of magnesium in Kuchakki hamun seem to concentrate along the drainage lines of several inflowing streams. These streams drain the adjacent highlands and apparently bring magnesium-enriched waters into the catchment.

Only traces of potassium were found in widely scattered places.

Nitrates

The dispersion pattern of nitrates (fig. 4) in Kuchakki hamun indicates that the principal concentrations are in the central part. The high solubility of nitrates permits recurrent solution of these salts during periods of flood; the dissolved salts evidently migrate

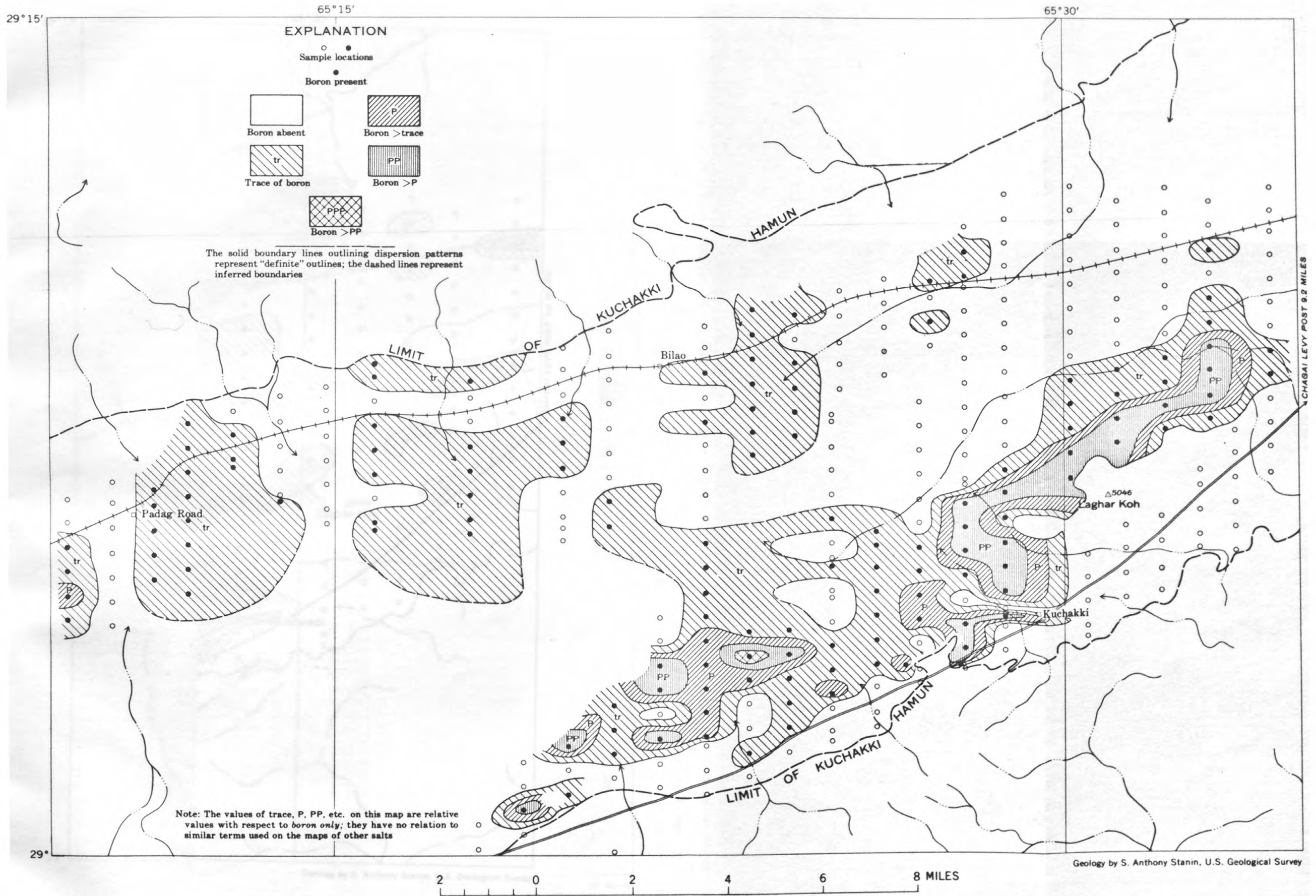


Figure 2.—Geochemical map showing the dispersion of boron in samples of surface soil and surface alluvium in Kuchakki Hamun

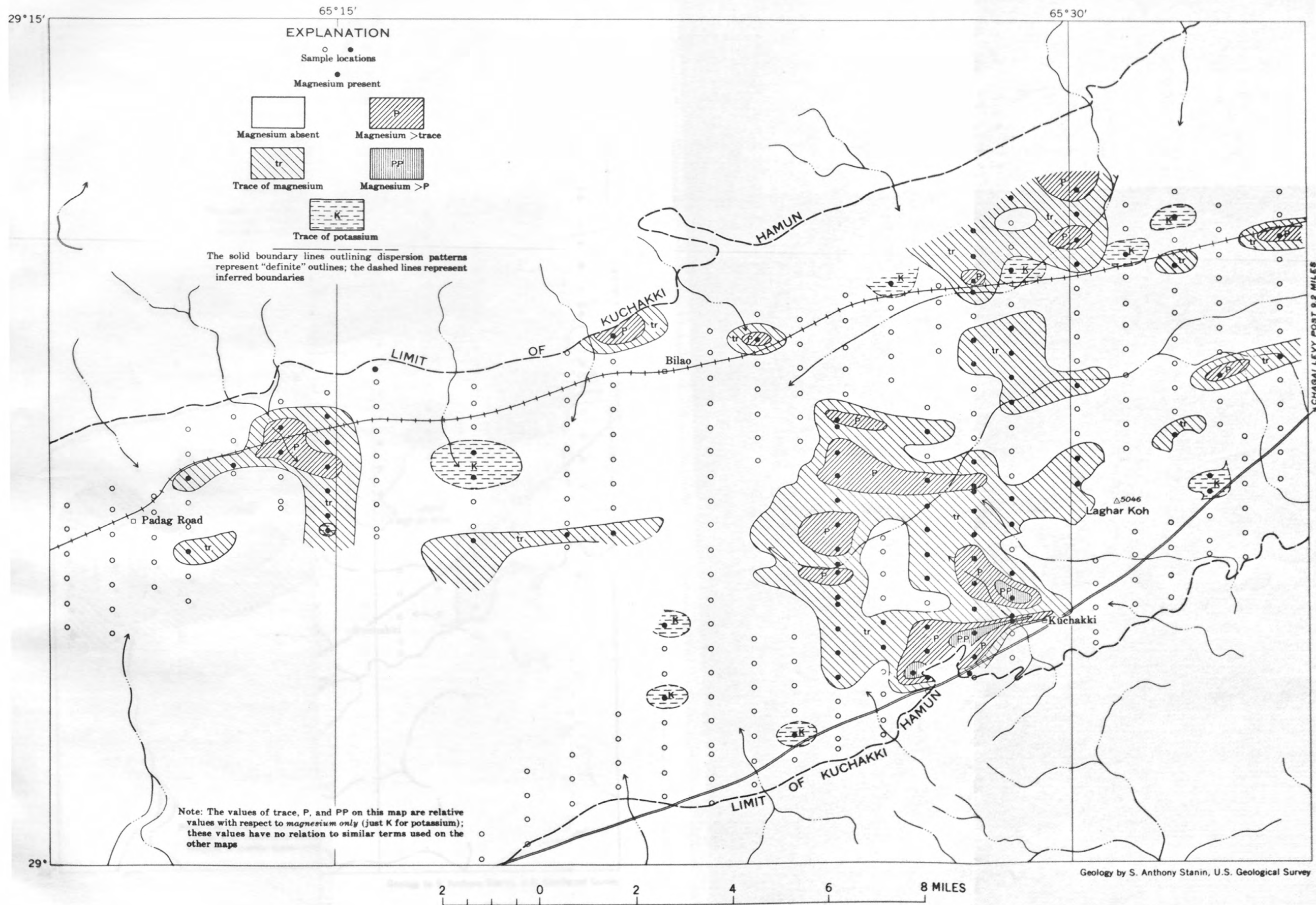


Figure 3.—Geochemical map showing dispersion of magnesium and potassium in samples of surface soil and surface alluvium in Kuchakki Hamun

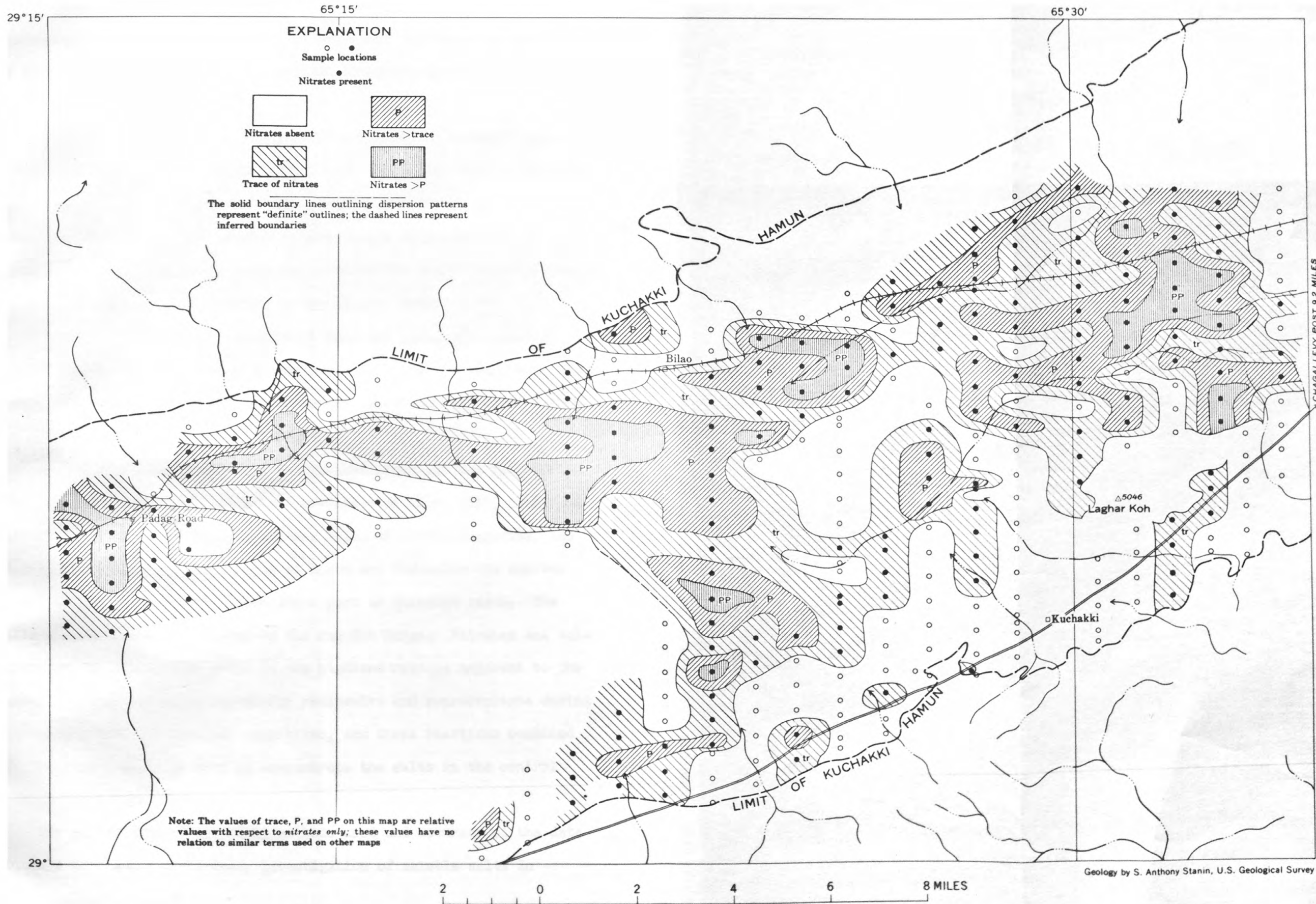


Figure 4.—Geochemical map showing dispersion of nitrates in samples of surface soil and surface alluvium in Kuchakki Hamun

basinward with the movement of aqueous solutions and reprecipitate closer to the middle of the basin during periods of desiccation.

Sulfates

About 80 percent of the soil samples collected in Kuchakki hamun contain sulfates. The sulfates (fig. 5) are found over much of Kuchakki hamun, and several large areas in the central part of the hamun contain concentrations of sulfate. Highly soluble salts of sulfate that are taken into solution and redistributed by inflowing waters probably account for the concentration of sulfates in the central area.

On the basis of partial analytical data and field observations, calcium sulfate in the form of gypsum seems to be the predominant sulfate mined; sulfates of sodium and magnesium may be present in lesser amounts.

SUMMARY

Preliminary geochemical work in Kuchakki hamun and the surrounding area indicates that the surface soil comprised of clay, silt, sand, and salt crust contains nitrates, sulfates, salts of boron, magnesium, and very little potassium. Most salts of boron and magnesium are concentrated in the southern and southeastern part of Kuchakki hamun. The salts seem to derive from rocks of the Ras Koh Range. Nitrates and sulfates seem to derive from rocks in the highland regions adjacent to the hamun. The soluble salts repeatedly redissolve and reprecipitate during alternating lake and dry-lake conditions, and these reactions combined with basinward drainage tend to concentrate the salts in the central area of the hamun.

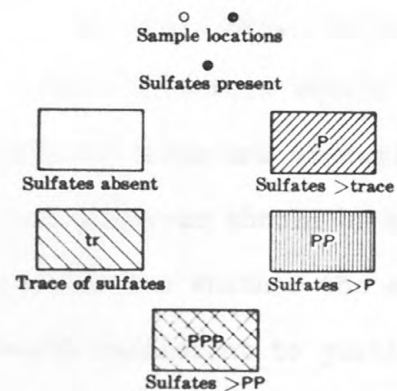
The reliability of the field methods used and accuracy of the data obtained during the preliminary investigation of soluble salts in

29°15'

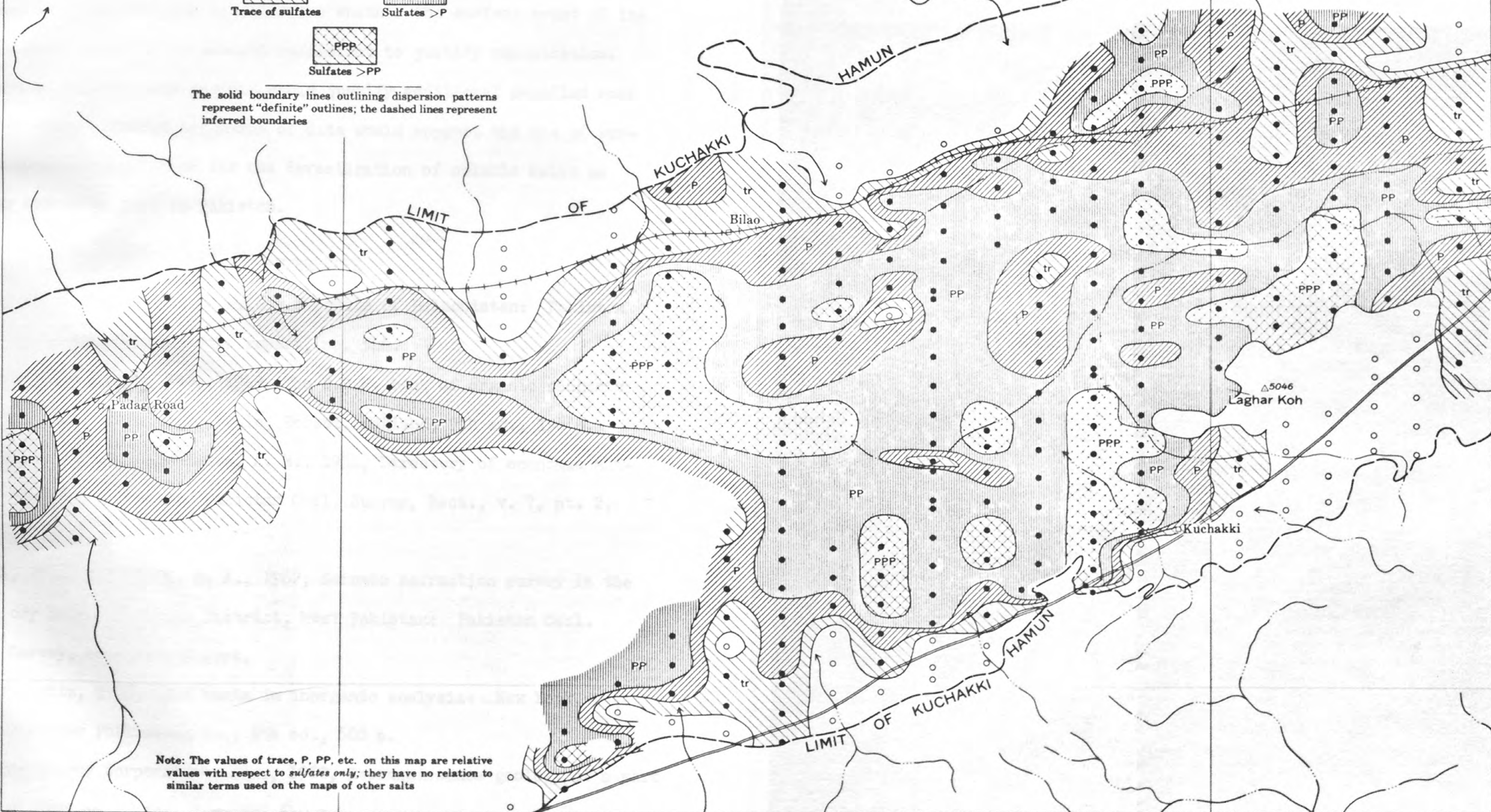
65°15'

65°30'

EXPLANATION



The solid boundary lines outlining dispersion patterns represent "definite" outlines; the dashed lines represent inferred boundaries



Note: The values of trace, P, PP, etc. on this map are relative values with respect to sulfates only; they have no relation to similar terms used on the maps of other salts

2 0 2 4 6 8 MILES

Geology by S. Anthony Stanin, U.S. Geological Survey

Figure 5.—Geochemical map showing dispersion of sulfates in samples of surface soil and surface alluvium in Kuchakki Hamun

Kuchakki hamun require additional appraisal. Collection of surface and subsoil samples at closely spaced intervals should be undertaken in Kuchakki hamun where the salts of boron and magnesium seem to be concentrated. Quantitative chemical analyses should be made on samples collected in Kuchakki hamun to determine whether the surface crust of the hamun contains salts in amounts sufficient to justify exploitation. Favorable quantitative results would justify additional detailed work in the area. General agreement of data would support the use of surface geochemical methods for the investigation of soluble salts in other evaporite pans in Pakistan.

REFERENCES

- Ahmad, M. I., 1948, Reh or kallar deposits of Baluchistan: Pakistan Geol. Survey, open-file report, no. 544.
- British Drug Houses, Ltd., 1949, The B.D.H. book of organic reagents for analytical use: Poole, Dorset, England, 9th ed., 196 p.
- Crookshank, Henry, and Heron, A. M., 1954, Directory of economic minerals of Pakistan: Pakistan Geol. Survey, Recs., v. 7, pt. 2, p. 1-146.
- Farah, Abul, and Ahmad, M. A., 1962, Seismic refraction survey in the dry lakes of Chagai District, West Pakistan: Pakistan Geol. Survey, open-file report.
- Feigl, Fritz, 1958, Spot tests in inorganic analysis: New York, Elsevier Publishing Co., 5th ed., 600 p.
- Hunting Survey Corporation, Ltd., 1960, Reconnaissance geology of a part of West Pakistan: Toronto, 550 p.

Richards, R. L., 1962, Evaporite resources of Pakistan: CENTO

Symposium on Industrial Rocks and Minerals, Lahore, Pakistan,
p. 267-274.

Snell, F. D., and Biffen, M., 1944, Commercial methods of analysis:

New York, McGraw-Hill, 753 p.

