Pak. j. sci. ind. res., vol. 37, no. 11, November 1994

# STUDIES OF POTASH BEARING EVAPORITE BASINS OF KOHAT KARAK SALT RANGE, NWFP PAKISTAN

M. ALAUDDIN, ARJUMAND KHAN, HAJRA MASOOD, FOZIA BEGUM, M.A. KHATTAK AND M. ASHRAF KHAN*

*PCSIR Laboratories, P.O. Peshawar University, Peshawar, Pakistan*

(Received November 30, 1992; revised July 7, 1994)

Potash-bearing minerals occur in nature with common salt and usually deposited in the evaporite basin on evaporation of brine water. In view of the huge deposits of common salt in Pakistan, particularly in Kohat-Karak evaporite basin, NWFP; investigations to locate the potash deposits in the common salt of the area were undertaken. The geology of the potash bearing deposits reveal their occurance in the form of lenticular beds associated with rock salts. The present study has successfully brought into focus areas of potash concentration in the above area which after refining may be exploited to meet the requirement of potash for fertilizer.

***Key words:*** Potash, Evaporite basin, Kohat-Karak salt range.

## Introduction

The term potash is usually used to describe potassium carbonate, but in economic geology and agriculture it has come to refer to potassium oxide, $K_2O$. This compound does not occur in nature, nor it is manufactured commercially; but it is used to compare compounds that contains different amounts of potassium. The equivalent potassium oxide content of a particular potassium salt is calculated and called its potash content. Pure sylvite contains the equivalent of 63.2% $K_2O$. Soluble potassium salts are important fertilizers [1], particularly for crops such as sugar cane which require a large supply of potassium for the production of sucrose.

Evaporite minerals include all deposits, either solid or liquid that have been precipitated or concentrated because of evaporation of water. The evaporite deposits of Pakistan are extended in vast areas of the salt range of Punjab and NWFP. The potash is generally in the form of polyhalite, kainite, sylvite which are found in association with other minerals like halite, Kieserite etc. [2]. The potash deposits of the area under study occur in the salt range of Kohat-Karak area and area found in the form of lenticular beds which are associated with rock salt.

The salt range of Punjab is one of the important known deposits of potassium as mentioned in the report of Economic Commission for Asia and Far East (ECAFE) region [3]. The potassium bearing materials consist of a mixture of common salt and magnesium sulphate with sylvite (KCl) and langbernite ($K_2SO_4$-$2MgSO_4$). The above study also mentioned that in the salt range of Kohat region, the rock salt is foliated rock and potassium-bearing salts occur in discontinuous lenticles and irregular foliae [4].

* Geological Survey of Pakistan, Peshawar, Pakistan.

Agriculture is the mainstay of economy of Pakistan. Tak-ing into consideration of the importance of potash in agricultural yield, the prospect of indigenous source of potash is expected to help in attaining self-sufficiency to this major area.

*Geology.* Inexhaustible reserve are known in the Kohat-Karak evaporite basin. The evaporite basin is indicated by the mineral assemblage of common salt and gypsum [3].

The term 'Basin' itself explains its restricted and enclosed condition which are intermittently connected with the main ocean. The nature of the sediments and their common change into facies in the area suggest that the Tethys sea was split up into a number of small basin with different depositional environment. The original identity of the Tethys sea was almost lost during the Eocene period, so the Kohat-Karak basin was more pronounced particularly for the evaporite environments.

This basin is stretched between Shin Ghar in the south, Lachin in the north, Shaidu Darga in the west and Malgin in the east. An ideal evaporite environment prevailed in the Eocene period (Fig. 1) and resulted in thick deposition of common salt and gypsum in the central part of the basin. The common salt and gypsum being the prominent minerals, are already being used commercially, but no other associated salt was investigated till the present work.

All the rock salt exposure in the area are identified with Bahadurkhel locality where it is quarried (Fig.2). The salt is dark with white bands. It is fine to coarsely crystalline. At places grains of grey and white colour are seen in fine to coarse grained beds. The bedding is prominently preserved in Bahadurkhel salt quarries where greenish shale intercalations are common. In other areas, the bedding is rather obliterated

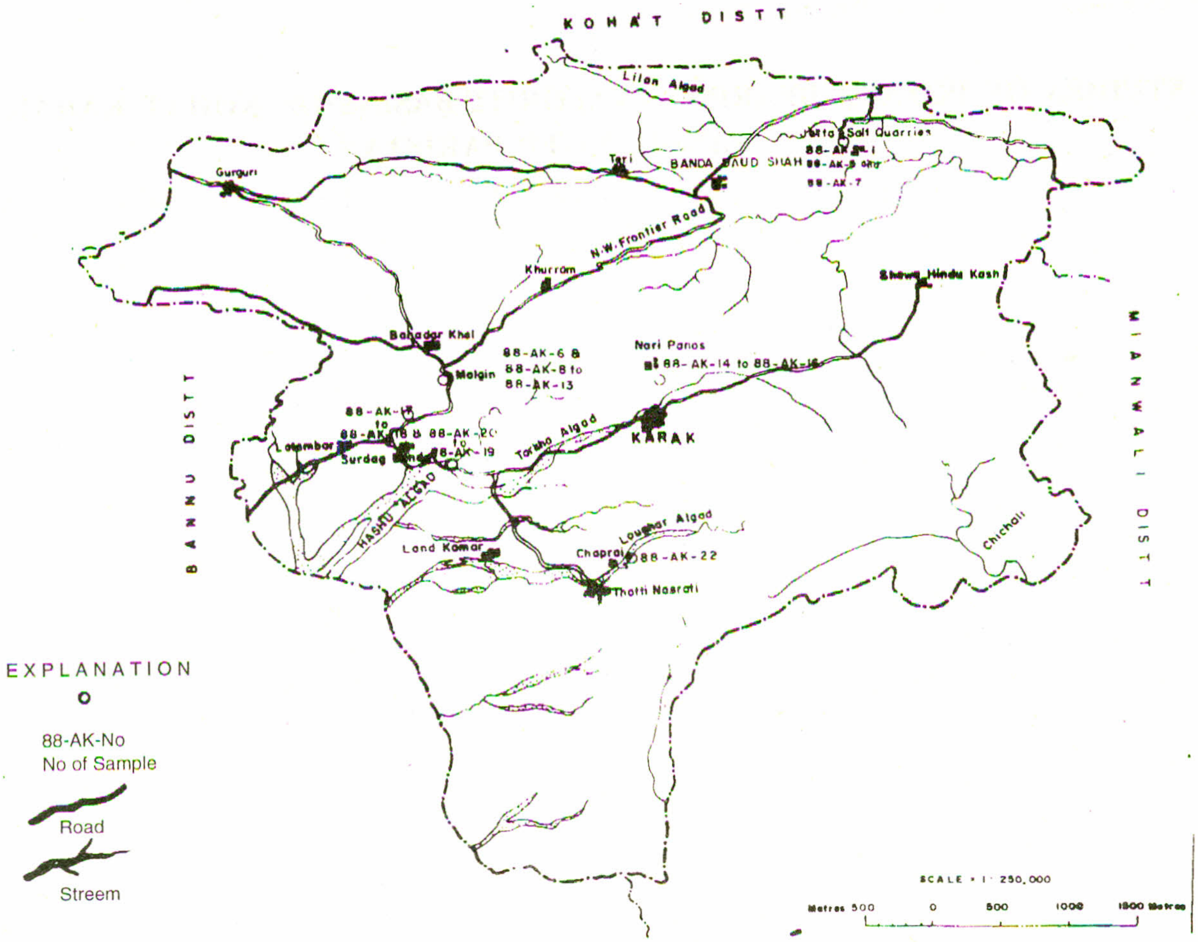


Fig. 1. Location of samples for potash investigation.

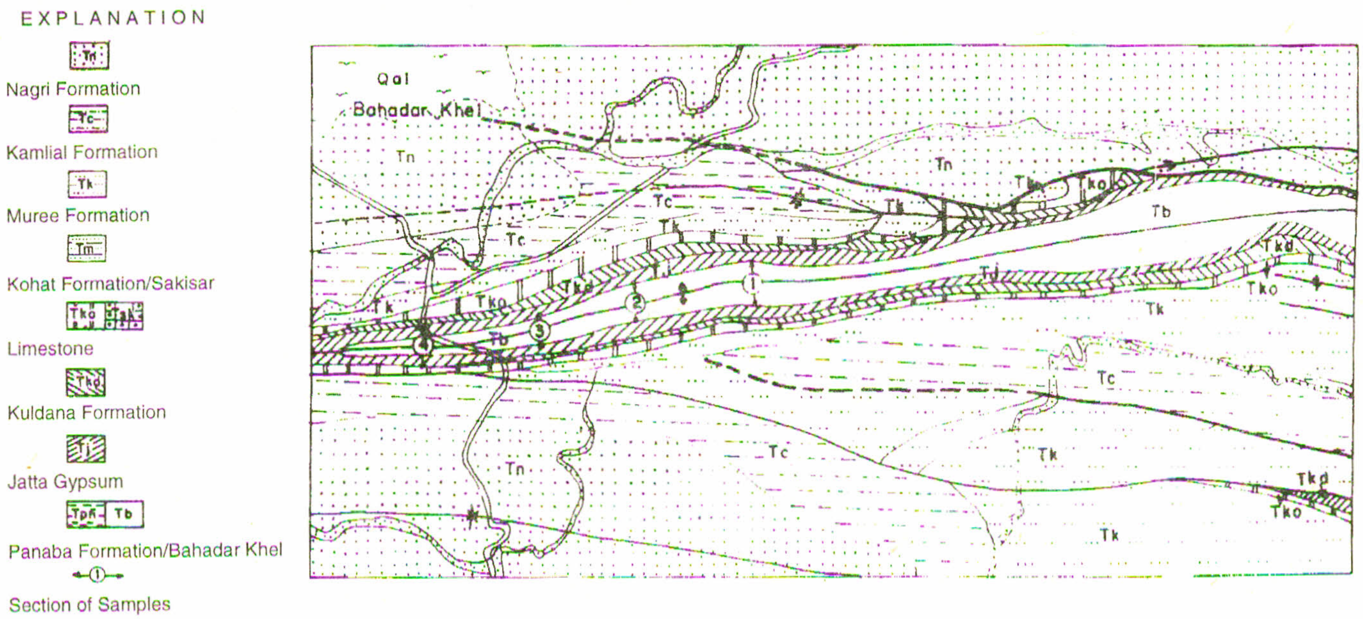


Fig. 2. Geological map of Bahadar Khel salt quarries showing the section of samples for potash investigation.

which may be due to diaparic movement of the salt. The salt gradually changes into shale unit known as the Panoba shale. Thick sequence of Panoba shale occurs where salt deposition is decreasing.

The Bahadurkhel salt is considered to have been deposited by the evaporation of saline water of sea origin and the thick deposition is due to frequent connection of the enclosed sea with the main sea. The potassium bearing salt, being present in the sea water, was expected to have been deposited with the common salt which is the subject of study in the present project.

Gypsum is calcium sulphate which is also deposited by the evaporation of sea water. The mineral has been deposited in enormous quantity in the area and stratigraphically lies above the Bahadurkhel salt and Panoba shale. This unit has laterally been changed into limestone facies known as sheikhan limestone. Besides, these clay, limestone of marine origin and other clastic deposits of continental origin are also found as a cover of the evaporite deposits but their evaluation is beyond the scope of this investigations.

### Experimental

The investigation consisted of sampling all evaporite outcrops known to contain potassium-bearing minerals. On the basis of preliminary chemical investigations of potash content, a number of salt exposures were marked for detailed investigations, in which the work of Bahadurkhel and Nari Panos salt quarries were completed. This was sub-divided into successive phases to have systematic approach for the location of the potash mineral.

In the first phase of investigations a few samples from each exposure, were collected and analysed. In this way approximate ideas of potash content of each outcrop of the salt was obtained. A number of transverse at regular intervals were made to study the occurance of potash. Samples were collected on the basis of the colour, degree of crystallization and impurities.

*Determination of Potash.* One gram sample was dissolved in distilled water on water bath. The insoluble matter was filtered off and solution was stored in plastic bottles which was used as stock solutions. Sulphate was present in traces. Nitrate was absent. Potassium was determined by Gallencamp flame photometer. The results are given in Tables 1-4.

### Results and Discussion

The evaporite deposits of Kohat-Karak area have been examined to establish the abundance and distribution of their potassium-bearing minerals. Table 1 to 4 indicate that 20, out of 73 samples, have high $K_2O$ contents that range from 5.10 to 6.30%.

TABLE 1. FIRST BATCH OF SAMPLES (EXPLORATORY COLLECTION).

| S. No. | Sample No. | % $K_2O$ | S. No. | Sample No. | % $K_2O$ |
|---|---|---|---|---|---|
| 1. | 88-AK-1 | 1.40 | 12. | 88-AK-12 | 0.62 |
| 2. | 88-AK-2 | 1.20 | 13. | 88-AK-13 | 0.87 |
| 3. | 88-AK-3 | 1.37 | 14. | 88-AK-14 | 1.45 |
| 4. | 88-AK-4 | 1.02 | 15. | 88-AK-15 | 1.42 |
| 5. | 88-AK-5 | 1.50 | 16. | 88-AK-16 | 1.25 |
| 6. | 88-AK-6 | 1.10 | 17. | 88-AK-17 | 0.42 |
| 7. | 88-AK-7 | 1.50 | 18. | 88-AK-18 | 0.25 |
| 8. | 88-AK-8 | 1.41 | 19. | 88-AK-19 | 1.20 |
| 9. | 88-AK-9 | 1.37 | 20. | 88-AK-20 | 1.32 |
| 10. | 88-AK-10 | 1.35 | 21. | 88-AK-21 | 1.50 |
| 11. | 88-AK-11 | 1.17 | 22. | 88-AK-22 | 0.57 |

TABLE 2. BAHADURKHEL (SECOND BATCH).

| S. No. | Sample No. | % $K_2O$ | S. No. | Sample No. | % $K_2O$ |
|---|---|---|---|---|---|
| 23. | Bh-1-AK-88 | 0.50 | 39. | Bh-20-AK-88 | 5.60 |
| 24. | Bh-4-AK-88 | 4.20 | 40. | Bh-21-AK-88 | 5.70 |
| 25. | Bh-5-AK-88 | 4.01 | 41. | Bh-22-AK-88 | 6.20 |
| 26. | Bh-6-AK-88 | 0.125 | 42. | Bh-23-AK-88 | 5.80 |
| 27. | Bh-7-AK-88 | 0.62 | 43. | Bh-24-AK-88 | 2.01 |
| 28. | Bh-8-AK-88 | 4.50 | 44. | Bh-25-AK-88 | 2.05 |
| 29. | Bh-9-AK-88 | 4.35 | 45. | Bh-26-AK-88 | 1.95 |
| 30. | Bh-10-AK-88 | 4.40 | 46. | Bh-27-AK-88 | 1.90 |
| 31. | Bh-11-AK-88 | 4.75 | 47. | Bh-28-AK-88 | 2.80 |
| 32. | Bh-13-AK-88 | 1.10 | 48. | Bh-29-AK-88 | 2.65 |
| 33. | Bh-14-AK-88 | 5.50 | 49. | Bh-30-AK-88 | 3.01 |
| 34. | Bh-15-AK-88 | 1.12 | 50. | Bh-31-AK-88 | 2.08 |
| 35. | Bh-16-AK-88 | 6.01 | 51. | Bh-33-AK-88 | 2.50 |
| 36. | Bh-17-AK-88 | 5.90 | 52. | Bh-34-AK-88 | 2.75 |
| 37. | Bh-18-AK-88 | 5.80 | 53. | Bh-35-AK-88 | 2.70 |
| 38. | Bh-19-AK-88 | 6.30 | | | |

TABLE 3. BAHADURKHEL AND NARI PANOS SAMPLES (THIRD BATCH).

| S. No. | Sample No. | % $K_2O$ | S. No. | Sample No. | % $K_2O$ |
|---|---|---|---|---|---|
| 54. | Bh-36-AK-89 | 5.20 | 61. | Bh-43-AK-89 | 5.40 |
| 55. | Bh-37-AK-89 | 5.70 | 62. | Bh-44-AK-89 | 5.15 |
| 56. | Bh-38-AK-89 | 5.01 | 63. | Bh-45-AK-89 | 6.20 |
| 57. | Bh-39-AK-89 | 0.50 | 64. | Bh-46-AK-89 | 5.60 |
| 58. | Bh-40-AK-89 | 5.50 | 65. | Bh-47-AK-89 | 6.30 |
| 59. | Bh-41-AK-89 | 5.10 | 66. | Bh-48-AK-89 | 6.31 |
| 60. | Bh-42-AK-89 | 5.01 | | | |

TABLE 4. BULK SAMPLE FROM BAHADURKHEL AND NARI PANOS (FOURTH BATCH).

| S. No. | Sample No. | % $K_2O$ | S. No. | Sample No. | % $K_2O$ |
|---|---|---|---|---|---|
| 67. | Bulk Sample No. 49 | 5.25 | 71. | Bulk Sample No. 53 | 5.60 |
| 68. | Bulk Sample No. 50 | 5.15 | 72. | Bulk Sample No. 54 | 5.30 |
| 69. | Bulk Sample No. 51 | 5.50 | 73. | Bulk Sample No. 55 | 5.44 |
| 70. | Bulk Sample No. 52 | 5.40 | | | |

In fertilizer terminology potassium oxide is called potash. Presently we are importing potash fertilizer at a high cost [5]. Pakistan imported 75,000 tons of sulphate of potassium and 15,000 tons NPK in 1989-90 costing about 310 million rupees. To popularise the use of potash and as an incentive to farmers the Government subsidises at 50% of the actual cost of potash fertilizer.

After separation and chemical processing [6] the potash deposits of Kohat-Karak will provide a valuable new source of fertilizer.

**References**

1. J. L. Cillson, *Industrial Minerals and Rocks,* (The American Institute of Mining), Metallurgical and Petroleum Engineering, New York), 3rd ed.
2. M. Z. Haque, Potash, A Fertilizer, Paper read at Second National Seminar on Development of Mineral Resources, Peshawar, Pakistan, May 1983.
3. Mineral Raw Material Resources for the Fertilizer Industry in Asia and Far East. The Economic Commission of Asia and Far East (ECAFE) Mineral Resources Development Services Report No. 28.
4. Russel I. Richards, Evaporite deposits in Pakistan, CENTO Symposium on Industrial Rocks and Minerals, Lahore, Pakistan, December (1962).
5. Source: Marketing Department, Agricultural Development Bank of Pakistan (ADBP), Peshawar.
6. Jack son, Warner, U. S. Patent No. 2, 480, 655 (1949).