Economics of the Indus River Sands

Dr. R. A. Khan
Tahirkheli

Chairman,
Department of Geology,
Peshawar University

Abstract

The Indus River has for centuries attracted the attention of the prospectors and geologists because of gold in its alluvials. The goldwashers are still working along the Indus River banks, using primitive methods to extract gold by washing sand and gravel. Recent studies conducted by the author show that an experienced goldwasher extracts about 1.05 grains of gold per cubic yard. The high value minerals left behind in gold tailings are scheelite, uraninite, and cassiterite. An attempt has been made in this paper to evaluate their proportions in the heavy fraction and bulk sands to see whether they can be won economically as co-products of gold.

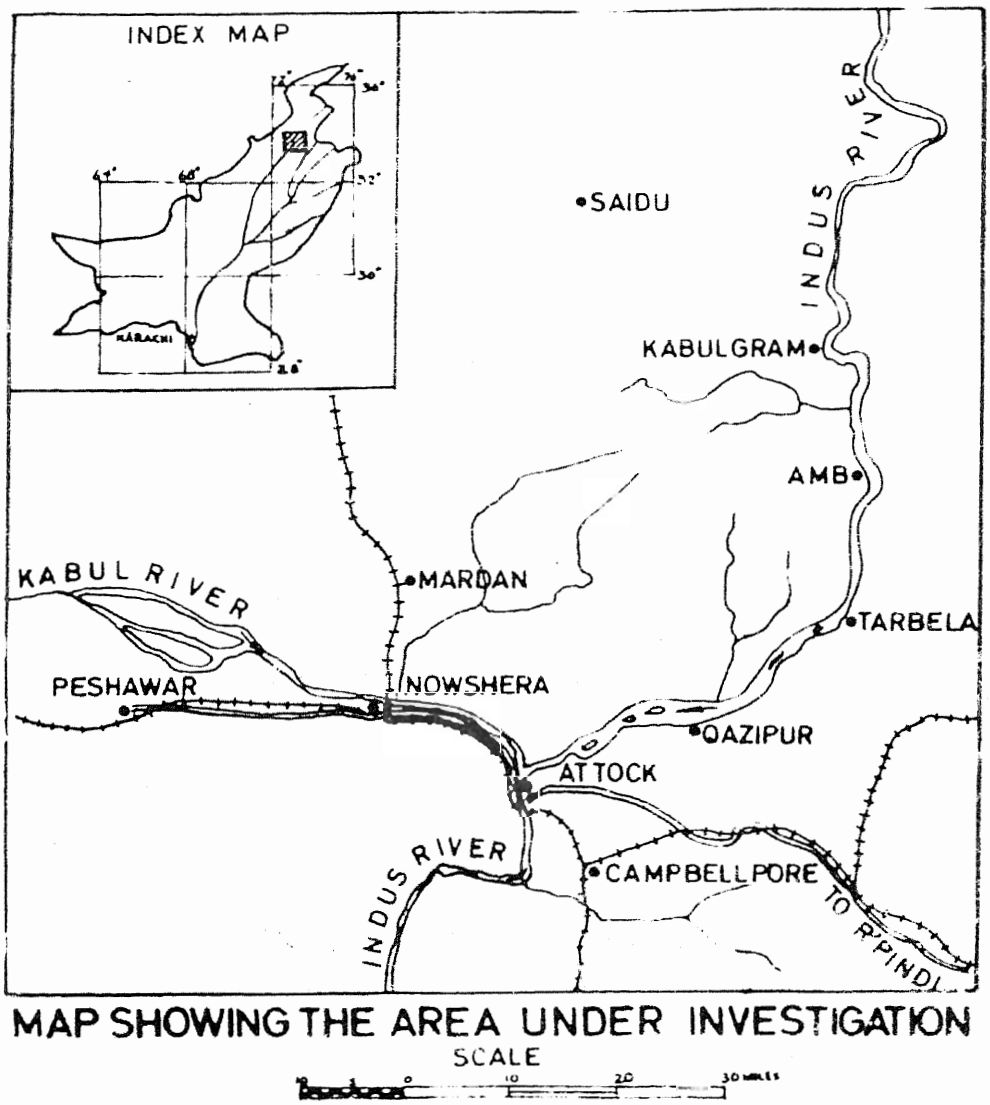
Introduction

The alluvial deposits of the river Indus have for many centuries formed a source of placer gold, and a goldwashing industry, conducted by methods which have changed little over the ages, remains today the livelihood of many families in the mountain valley traversed by this great river. Until recent years little precise information has been available on these activities.

In 1957, however, radioactive minerals and scheelite were found in the black sand concentrate prepared by the goldwashers, and publicity given to these discoveries resulted in many enquiries seeking factual data. These stimulated a study of the alluvials with two-fold aim of reviewing their potentialities for large scale commercial exploitation and of investigating the light which they shed on the geology of the unexplored crystalline rocks drained by the river. Comprehensive information on this work is beyond the scope of this publication, hence the economics of the part of the Indus alluvials between Attock and Amb is included in this paper.

After emerging from the mountain confines, the Indus valley gradually widens downstream from Amb. A great accumulation of the alluvial deposits is situated in this region, where the valley at places is from 2 to 2½ miles across. Numerous sand bars here have become permanent islands in the river. This area is readily accessible both by metalled and fairweather roads and by rail; the rail head at Haripur being only 12 miles away and that at Attock on the bank of the river, still closer. Most of the villages

here are electrified, and cheap electric power could be made available for mining. These various factors make a placer mining project between Amb and Attock much more attractive, and therefore this sector of the alluvials has been given most attention.



MAP SHOWING THE AREA UNDER INVESTIGATION

Field Sampling and Laboratory Procedures

Between Attock and Amb many closely spaced samples were

collected. The samples are of three kinds, bulk sample, handpanned concentrates and goldwashers' residues. The first untreated material has been utilized for size analysis and quantitative mineralogical study. The goldwashers' residues, which are highly concentrated, have formed the main source of material for studying scheelite, cassiterite, gold, uraninite, and other rare minerals.

For microscopic examination the heavy and light minerals were separated by bromoform (sp. gravity 2.89) after extraction of the magnetite by a hand magnet (the amount of magnetite being weighed), and representative slides of each fraction were prepared for grain counting. From 200-300 mineral grains per slide were counted.

The size analyses were conducted on bulk samples and bromoform separates, using sieves of 16, 30, 60, 120, and 200 B.S.S. mesh. According to Wentworth's classification these are designated very coarse, coarse, medium, fine, very fine, and silt sizes.

Mineralogy

The minerals identified in the non-opaque heavy suites of the Indus alluvials are garnets, hornblende, augite, diopside, hypersthene, apatite, epidote, olivine, brookite, zircon, vesuvianite, muscovite, biotite, phlogopite, cassiterite, scheelite, sillimanite, chlorite, anatase, topaz, barite, carbonates, corundum, monazite, uranothorite and leucoxene.

Among the opaque minerals pyrite, magnetite, chalcopyrite, ilmenite, haematite, limonite, picotite, galena, uraninite and a few other unidentified species are recorded. Gold is extremely rare and has been found only in goldwashers' highly concentrated residues.

TABLE 1 HEAVY MINERAL CONCENTRATES(MAGNETITE-FREE>2.89)EXPRESSED IN Lbs./Cu.Yd.

LOCALITY	Apatite Sillimanite	Brookite	Cassiterite	Calcite Dolomite	Epidote Zoisite Clinozoisite	Garnet	Hornblende	Hypersthene Augite Diopside	Micas	Monazite	Opaque minerals	Rutile,Tourmaline Corundum Anatase Kyanite	Scheelite	Uraninite	Zircon
KABULGRAM	2.1	1.1	.7	9.0	8.3	14.2	144.2	28.3	68.0	.46	12.7	2.3	2	4	7.8
AMB	1.8	.4	.85	11.0	2.9	28.7	131.3	13.0	64.0	.3	8.3	2.7	4	.47	5.7
QAZIPUR	1.7	.8	.8	12.4	6.9	64.7	109.4	18.2	18.3	.3	16.3	3.1	3.5	.5	4.7
ATTOCK	1.4	1.4	1.1	86.0	11.1	180.0	90.0	12.7	68.2	.34	19.4	2.6	31	.41	6.4

Magnetite, garnet, common hornblende, carbonates, and biotite

are the major constituents of the heavy mineral suites, recorded in order of abundance.

Size analyses of bromoform separates show that most of the valuable minerals in the alluvials are concentrated in the fractions of fine mesh. Uraninite, gold, monazite, and apatite are confined to the very fine and silt sized grades, while zircon, rutile, scheelite, cassiterite, corundum, and sillimanite occur not only in these fractions but also in considerable amount in the fine sized grades.

Economic Geology

The success of a large scale mining operation in the alluvials must depend almost wholly on the tenor of gold, uraninite, tinstone, and scheelite, which are the only high value minerals present. It has been shown that average yield of gold in the samples treated by an experienced goldwasher is 1.05 grains per cubic yard. At a price of £ 12.10s per fine ounce of gold, this equals about 6½d per cubic yard. This is, however, the yield from specially selected beds of sand, naturally enriched in heavy minerals. Since a dredge must work all the alluvium, without a special selection, the yield by dredging would be very much less than that from selective mining. Even if one assumes that the manual operation of the goldwasher is so inefficient as to lose half the gold, and that mechanized working would be more efficient, it must be admitted that the yield from dredging, taking all sand and gravel as it comes, would be very much less than 6d per cubic yard. This is well under half the poorest recovery obtained from commercial dredging operations elsewhere (e.g. Gold Coast, New Zealand). According to Skinner's Mining Yearbook an overall recovery of 2-2½ grains per cubic yard is necessary to be profitable. The minimum overall costs are to be about 1s.1d. to 1s.4d. per cubic yard treated.

From radiometric and mineralogical assays it appears that a ton of the goldwashers' final concentrates contains from 2 to 5 pounds of uraninite. Assuming that because of high density most of the uraninite is retained in these concentrates, the content of uraninite in the parent crude sand must be around 1 1200 of this amount, say around 0.0002 per cent, a figure which is in keeping with the radiometric surveys where the thorium from monazite and the radioactivity of zircon are taken into account. Taking the current price of uranium oxide at 35s per pound and assuming that half of this represents the cost of treatment after mining, then the value of the recoverable uraninite in the alluvium selected by the goldwasher is only about one penny per cubic yard. This is the tenor in small local placers specially chosen for their high grade. The tenor in the alluvials considered over all is very much less than this.

Similarly the tenors of tinstone and scheelite have been estimated visually to be around 1 ounce and 0.02 ounce per cubic yard respectively; but this estimate based on grain counts is almost certainly much too high for tinstone. Tinning tests using zinc and hydrochloric acid show that cassiterite is much less abundant than is indicated by visual estimates.

Considered overall, therefore, even the small patches of heavy mineral concentrates, on which the indigenous gold industry is based, have a mineral value amounting to well under one shilling per cubic yard. Since the grade of the material which would have to be worked in a large scale mechanized operation would be much lower than that of selected patches operated on manually, it is plain that there are no commercial prospects for any large-scale dredging of the Indus River placers between Attock and Amb.