

Gold in the Beach Placer Sands of Chavakkad-Ponnani, Kerala Coast, India

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Abstract: Although sporadic mining of placer gold from river beds is not uncommon in India, there is no documented literature on the occurrence of gold in the beach placer sand deposits of the country. While characterizing the heavy minerals of the Chavakkad-Ponnani (CP) beach placer sands along the North Kerala coast, the association of gold with the pyriboles in these sands has been observed. A native gold grain of about 25 μm was seen to occur as an inclusion within an amphibole of hornblende composition. The pyriboles of the CP deposit are angular to sub-angular indicating a nearby provenance that may be in the upstream reaches of the Ponnani River in the districts of Malappuram and Palakkad or further north in the auriferous tracts of the Wynad-Nilambur or Attapadi regions. It is argued that the occurrence of native gold in CP deposit is not a freak occurrence and that it warrants thorough investigation of all the pyribole-ilmenite-rich placers to examine the possible presence of gold and its abundance in the beach placers of northern Kerala coast.

Keywords: Beach sands, Placer deposits, Gold, Kerala.

INTRODUCTION

Gold occurs in India in diverse geological settings. Gold occurs as lode gold, in stratiform sulphide deposits, as disseminations in volcanic rocks, in volcanogenic polymetallic sulfide deposits, in conglomerates, quartzites and greywacke, in epithermal veins of Tertiary age, in river placers, and in laterite/weathering profiles (Radhakrishna and Curtis, 1991). From the mining and recovery point of view, the deposits of gold that are easiest to work are the alluvial placers because in such deposits gold occurs as loose discrete grains in its native state. The alluvium of most rivers that drain the auriferous tracts of India contains disseminated gold. Names like *Suvarnarekha*, *Suvarnavati*, *Honnu hole*, *Ponnu Puzha* (golden stream) indicates that these rivers have been the source of alluvial gold. Easily accessible gold lodes and gold-rich pockets of river placers have all been exploited and even today, gold is mined sporadically from river beds by the local people and recovered by panning (eg. *Paniyars* in the Nilambur Valley of north Kerala; Radhakrishna and Curtis, 1991). Gold has, however, not been reported from the beach placer sand deposits of India. In this communication the occurrence and association of native gold in the Chavakkad-Ponnani (CP) beach placer sands of northern Kerala coast that was recorded during the investigation of mineral properties of

various heavy minerals associated with the CP deposit is reported.

MATERIALS AND METHODS

For our investigation, a total of twenty one sub-samples, each weighing about 10 kg, were obtained through CESS-Thiruvananthapuram from the 18 km stretch of the CP area taken at about 1 km interval along the coast. From the samples, heavy minerals were isolated by gravity separation (sink-float method) using a heavy liquid (bromoform; $d = 2.88$). It was noticed that samples could be distinctly classified as low-grade with <10% total heavy mineral (THM) content by weight, medium-grade and high-grade (>80% THM). A composite sample prepared by proportionately mixing the individual sub-samples (approx. 1 kg each) had THM content of 25.4% (Table 1) which is slightly higher than that reported by Krishnan et al. (2001).

The heavy minerals were characterized using various techniques. The distribution (by number of grains) of heavy minerals was determined by manual grain counting using a stereo-zoom microscope (Leica-Wild M8). Polished grain mounts were studied using reflected light microscopy (Leitz/Leica Orthoplan). Polished grain mounts were also studied using an SEM-EDAX (JEOL JSM-840A). Quantitative

Table 1. Modal abundance of heavy minerals in CP Deposit

Heavy Mineral	%
Ilmenite	7.4
Rutile	0.2
Pyribole	13.1
Garnet	2.9
Sillimanite	1.2
Zircon	0.3
Miscellaneous	0.3
Total	25.4

mineral compositions were obtained on selected samples using EPMA (CAMECA SX-100) at Indian Bureau of Mines, Nagpur and at Wadia Institute of Himalayan Geology, Dehradun keeping the electron beam spot size at 0.5 μm .

RESULTS AND DISCUSSION

Pyroxenes, amphiboles, garnet and ilmenite were studied in the polished grain mounts. Ilmenite shows intergrowth

with hematite (Fig. 1a); and garnets show numerous inclusions (Fig. 1b). The garnets are mainly of almandine variety. Most of the pyriboles (i.e., pyroxene and amphibole) are amphiboles of hornblendic composition and the pyroxenes are hypersthene and diopside. Amphiboles occasionally contain inclusions of other mineral phases. In one such amphibole an inclusion of about 25 μm that showed very high contrast in back-scatter electron image was noted (Figs. 1c and 1d). The grain was much brighter than the associated iron-titanium phases. When analyzed at a central point for ten common oxides (such as SiO_2 , Al_2O_3 etc.), the total concentration of these elements was found to be only 2.4% and most of this was iron oxide and silica. The analysis was repeated two more times at intermediate and peripheral part of the grain that yielded total analysis of 2.52% and 2.95% respectively with the same oxides. The inclusion was analyzed again and scanned for all elements that are detectable by all four spectrometers attached to the EPMA (having crystals LIF, TAP and 2 PET). Gold was detected as the major constituent of the grain in the

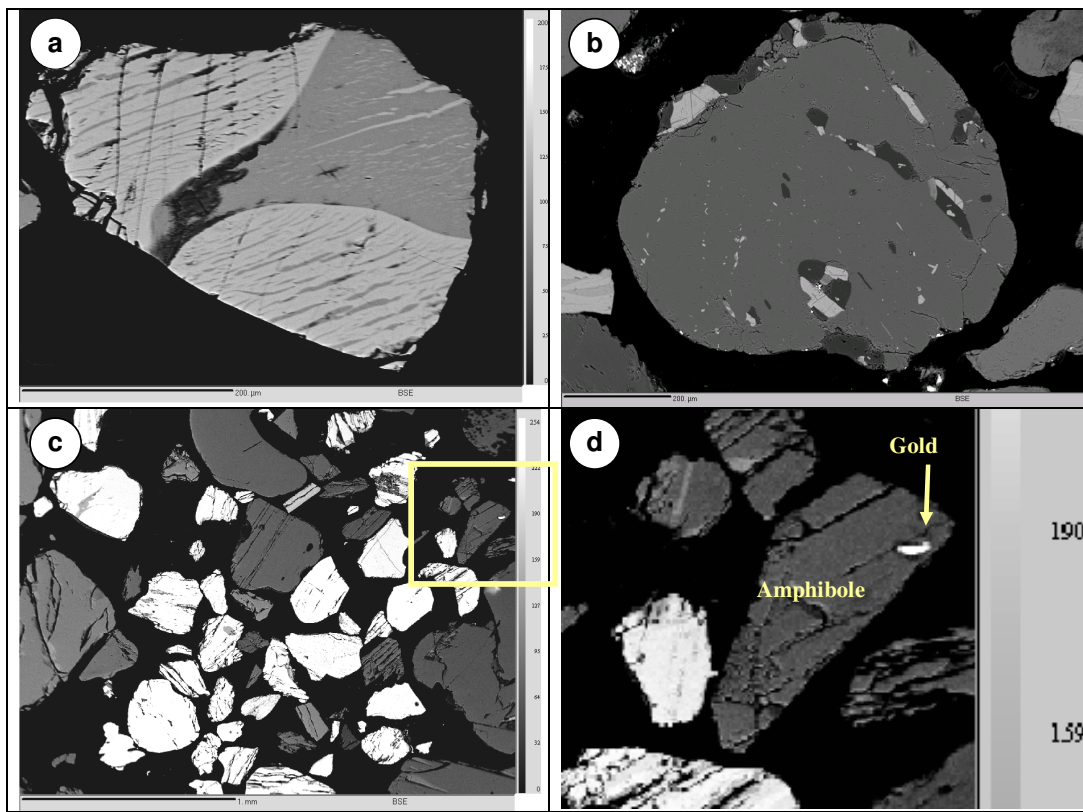


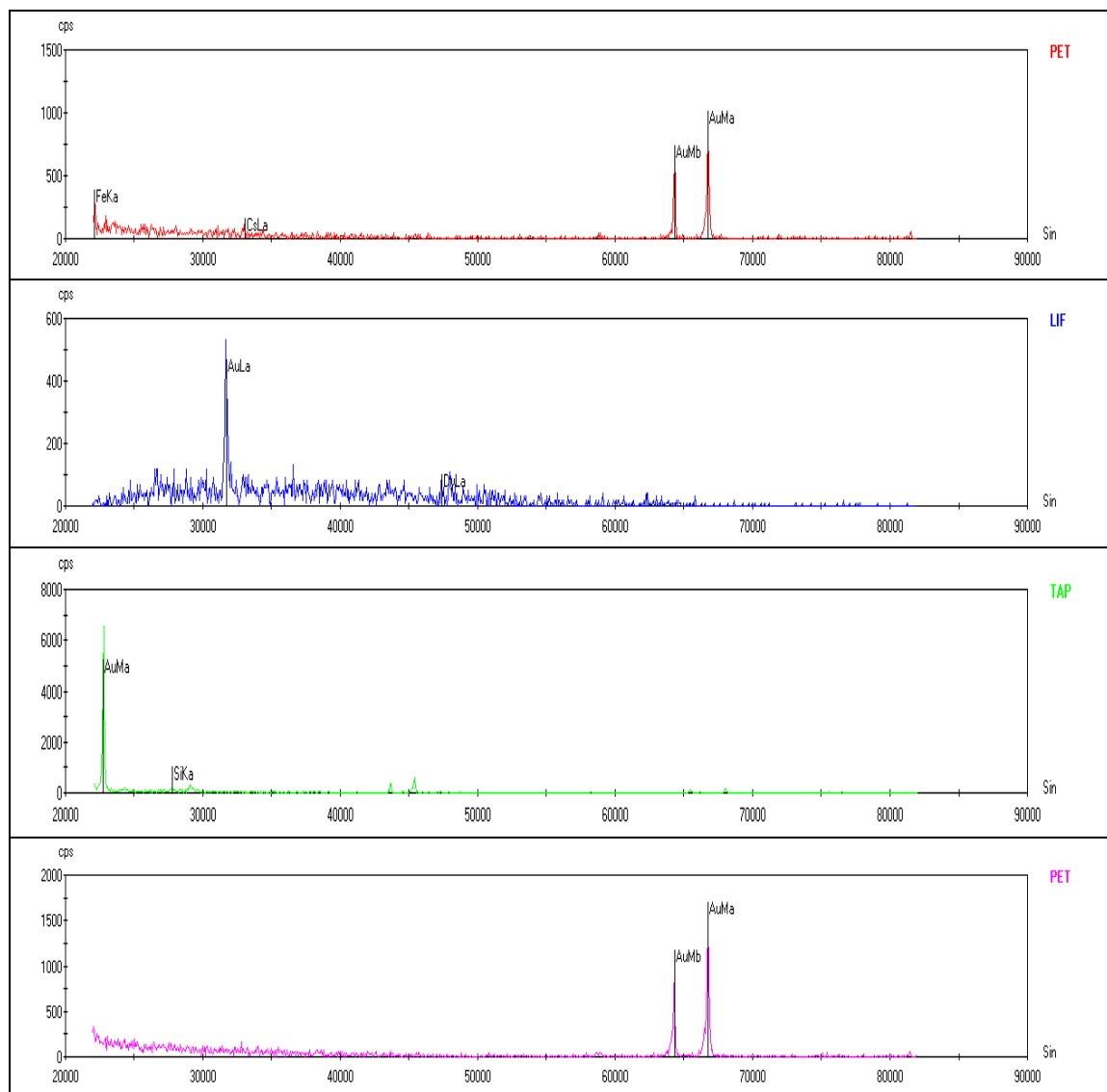
Fig.1. Back scattered electron (BSE) images showing internal characters of heavy minerals in the Chavakkad-Ponnani beach placer sand deposit. (a) Ilmenite (grey) showing intergrowth structure with hematite (whitish). (b) An almandine garnet (bigger grain with grey colour) having inclusions of quartz (dark grey), ilmenite (light grey) and hematite (whitish). (c) A general view of heavy minerals; lighter tone minerals are Ti-Fe oxides and darker tone minerals are silicates (mainly pyriboles and garnets); the elongated amphibole within the inset box hosting a grain of gold. (d) A magnified view of the amphibole (hornblende) of the previous figure showing the mode of occurrence of gold.

Table 2. Chemical compositions of major heavy minerals in the CP Deposit

Mineral	Na ₂ O	K ₂ O	MgO	CaO	MnO	FeO	SiO ₂	Al ₂ O ₃	P ₂ O ₅	TiO ₂	Cr ₂ O ₃	Total
Hornblende	1.70	1.24	11.98	11.55	0.28	15.14	43.81	9.97	0.01	1.51	0.02	97.21
Ilmenite	0.04	0.00	0.48	0.01	0.64	52.11	0.00	0.03	0.00	46.34	0.14	99.79
Almandite	0.00	0.00	5.54	1.09	0.74	34.72	34.54	21.94	0.00	0.00	0.00	98.57

WDS-spectra (Fig. 2). It was thus concluded that the inclusion is a grain of native gold. Minor peaks of Si and Fe were detected indicating them to be the main impurities with the gold grain. The host amphibole is identified to be a hornblende and its composition is given in Table 2. However, we presume that the impurities detected are not from the gold grain but due to signals from the host amphibole. This is because the oxides that are detected in the gold grain are

almost the same oxides as that of the host amphibole and their quantities are almost in reciprocal amount to the host. Moreover, gold in nature never contains oxides as impurities but is often alloyed with some chalcophile elements like Ag and Cu. Picking up of signals from the host mineral might have happened because of extreme thinness of the gold grain (either in flaky form laying parallel to polishing surface or thinned down due to polishing) so

**Fig.2.** WDS spectra of the inclusion in amphibole showing the peaks of gold in all the four spectrometers of EPMA.

that the electron beam penetrated through it to get signals from the host amphibole.

Beach placer sands in India are mainly mined for ilmenite, rutile, garnet, sillimanite, zircon and monazite. However, the placer sands in northern Kerala coast contain considerable quantity of pyriboles (i.e., the pyribole-ilmenite province; Krishnan et al. 2001). These are considered to be waste as they have no market value and are a hinderance in the beneficiation process to separate garnets. Other deposits containing pyriboles in the northern province are located at Valarpattanam-Azhikode (VA) and Azhikode-Chavakkad (AC) areas. These deposits mostly derive their heavy minerals from the northern districts of Kerala. The rivers and their tributaries in these areas traverse through the auriferous tracts of Wynad-Nilambur and Attapadi valley where very high pure gold has been reported from the weathering profiles and alluvial placers in addition to the primary lode-gold mineralization in vein quartz traversing the Precambrian amphibolites and granite gneisses (Santosh and Oman, 1991; Santosh et al. 1992 and Nakagawa et al. 2005). Therefore, the incidence of gold with pyriboles in these beach sands is perhaps not a freak occurrence and such occurrences can be expected in all other pyribole-ilmenite bearing beach sands of North Kerala. The mode of occurrence of gold in these sands may be similar to the present case (i.e., inclusion in amphiboles) because if the gold is liberated or released from the host amphibole, then it may be deposited in upstream reaches as alluvial placers before it reaches the beach because of its high specific

gravity. It can also be expected that some quartz grains might contain inclusions of gold because in the provenance (greenstone belts), primary gold occurs mainly with quartz veins and to a lesser extent in the altered meta-volcanic wall-rock; but in our heavy mineral fraction we have not encountered such a case. The gold grain under discussion and its mode of occurrence as an inclusion in an unaltered amphibole is indicative of its derivation from the Precambrian amphibolites in the hinterland; may be in the Wynad-Nilambur valley or in the Attapadi valley. Systematic exploration is highly essential to study these deposits with a focused aim of to establish the occurrence of gold and evaluate its abundance in the beach placer sands along the northern Kerala coast.

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