



Ancient Gold Mining Activities in India - An Overview

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Abstract

Gold was obtained through washing or panning of the river sands during initial periods of civilisation. With the advent of knowledge of metallurgical processing of ores it was recovered through mining of in-situ quartz reefs, and then from auriferous sulphide ores. The metal mining activities are evidenced in the form of large number of 'ancient metal mines' or 'old workings' and 'placer mining sites' almost in all the States of India. Gold artefacts have been found in Early Harappan sites. Some of the ancient gold mines are found to be more than 200 metres deep, probably the deepest of that period in the world. Geological surveys, investigations and explorations initiated during nineteenth century, are being continued mainly by the field officers of Geological Survey of India in different parts of the country to locate the gold prospects i.e. past and the future. Ground geological and archaeological findings related to gold have been brought out by several workers. The voluminous data existing on the ancient gold mining activities has been synthesized here for an overview.

Keywords: ancient gold mining activities, India

1. Introduction

In Since ancient past the metal gold is quite prevalent in Indian culture as is evidenced from its mention in Vedas, Epics, Puranas, Upanishads, Buddhist, Jaina and Sanskrit and other old texts. Archaeological studies have revealed the presence of gold ornaments from Neolithic phases, Chalcolithic sites, PGW levels, megalithic burials and Early Historic sites [1, 2]. As a result of thousands of years of old civilisation and the acquaintance of our ancestors to mining techniques, we have inherited myriad of ancient mine workings particularly in areas of gold [3]. Presence of several clans of expert gold panners (Sonjharias, Jharias, Jharas, Jhoras, Sonzaras in M.P. and Chhattisgarh; Dhoras, Jhoras, Jharas, Toras, Dokras in Chhota Nagpur; Sonwals in Assam, Jalgars in Karnataka, Balti in Ladakh in J. & K., Daolas in H.P. Sunajharias in Odisha; Nyaarias in North India and Panners in Kerala) in different parts of the country further support it [4, 5, 6, 2]. The 'ancient metal mines' identified in different States are popularly called 'old workings'.

Modern geological surveys and detailed field investigations have located incidence of large numbers of gold mining sites in almost all States. It is indicative of the fact that almost all the auriferous areas were known to and explored by the ancient gold prospectors. It is corroborated with the occurrence of repetitive nomenclatures of several physiographic features revealing gold (Sona, Swarna, Ponnun, Honna etc. in

Indian languages) viz. rivers such as Swarnamukhi in A.P.; Sonajori in Chhattisgarh; Sona, Subarnarekha in Bihar/ Jharkhand; Swarna in Karnataka; Son in M.P.; Ponnaiyar in Tamil Nadu; Sonawadi in U.P. [7]; and hills such as Bangargatti, Honnegudda in Karnataka; Sona Pahari, Sonadehi Dongri in Chhattisgarh; Sona Pahar in Meghalaya; Sonaria in Rajasthan, Sunadeipahar in Odisha. Similar metal indicating nomenclatures also exist for many ancient gold mining sites.

2. History of gold mining in India

The history of gold mining in India, as compare to other metals, is still obscure [8]. Major periods of gold mining activities identified are (i) ancient period (3900 BC to 500/ 600 AD) (ii) period between 1500 AD and 1870 AD and (iii) period between 1870 and 2002 AD. Most of the gold mining activities belonged to or initiated during the ancient period. The reasons for the absence of gold mining activities between first and the second period are not known; and may be called as period of recession. The second period was of invasions on Indian Territory; only sporadic gold mining continued; hence, trading (gold inflow) overtook the mining. Modern geological surveys began in the third period; mining re-started in Kolar, Hutti, Gadag and Ramagiri goldfields.

After reaching 3,000 m depth the famous Kolar mine, which produced a total of 800 tonnes of gold during its life time, was closed in 2001 [9]. Patil [10] also opined that major gold mining activities were initiated during Pre-Ashoka period (+2000 years BP); and were

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characterised by mining of higher-grade portions of the auriferous reefs; limited in depth due to ground water problems though an old mine in Hutti area reached up to 195 m deep. In Bellara area some ancient gold workings are found to be up to 640 feet deep [11], probably the deepest gold mines of that period in the world; and indicate towards the great mining skill of the ancient Indians.

3. Ancient gold mining activities in hard rock terrain

During the earliest segment of ancient gold mining in India, major production came from placer deposits; gold was recovered through washing or panning of river sand or gravels. With the advent of metallurgical knowledge, gold was recovered by in-situ mining of quartz reefs and auriferous base metal ores. Modern geological surveys, which commenced in nineteenth century during British period, have identified a large number of ancient gold mining and metallurgical sites in India. Visible native specks, man-made depressions

or chain of depressions sub-parallel or in strike continuity of the mineralised zones, dumps of crushed quartz or mine muck, stone grinding implements (pestles, mortars/ poly mortars, rock breakers or mullackers), in-situ pounding marks, ancient panned rejects, slags and analytical auriferous anomalies etc. played important role in identification of these sites [12, 13, 14, 15, 16, 17, 18, 19].

These mine workings occur in the form of shallow pits, trenches, large open-cast pits, inclines, vertical shafts and underground mines with different levels or galleries. The vertical narrow openings or shafts (lined or un-lined) were meant for different objectives viz. entry into the mines, haulage of ore, dewatering, ventilation etc. The ancient prospectors possessed the knowledge of 'fire-setting' to break the rocks for mining and ways for dewatering the sub-surface mine water [20].

State-wise details of the ancient gold mining and allied activities identified are presented in Figures 1, 2, 3 and 4, and are described as below.

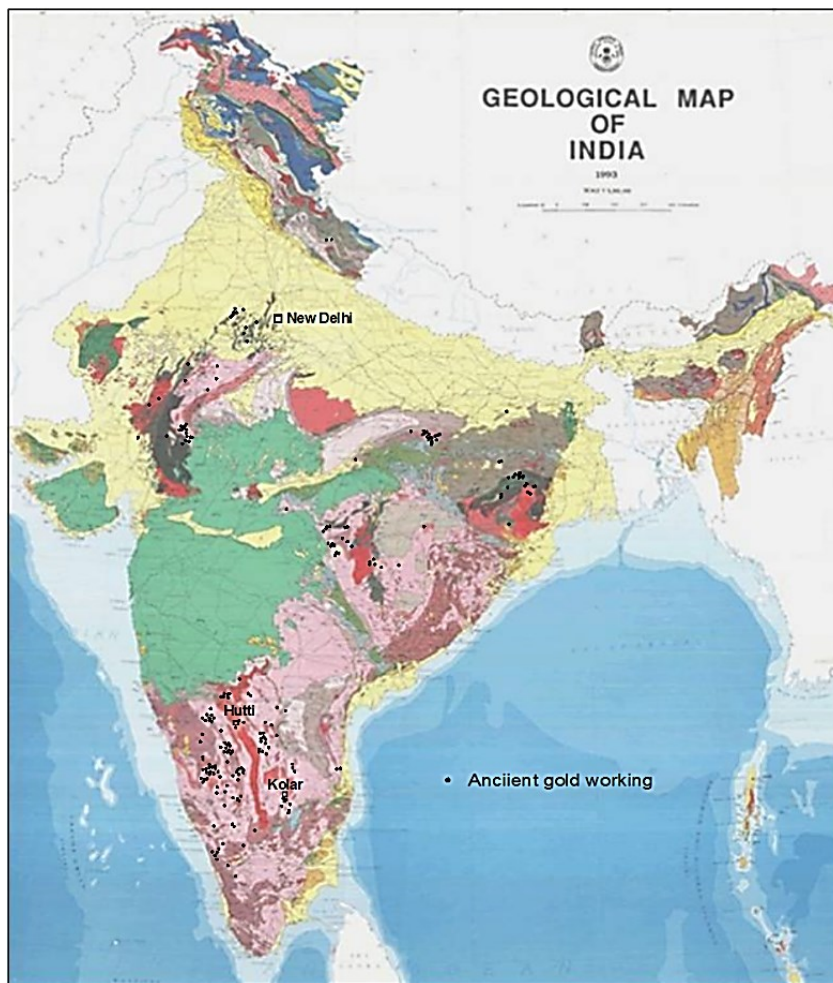


Fig. 1: Geological map of India (after GSI, 1993) showing distribution of ancient mine workings for gold

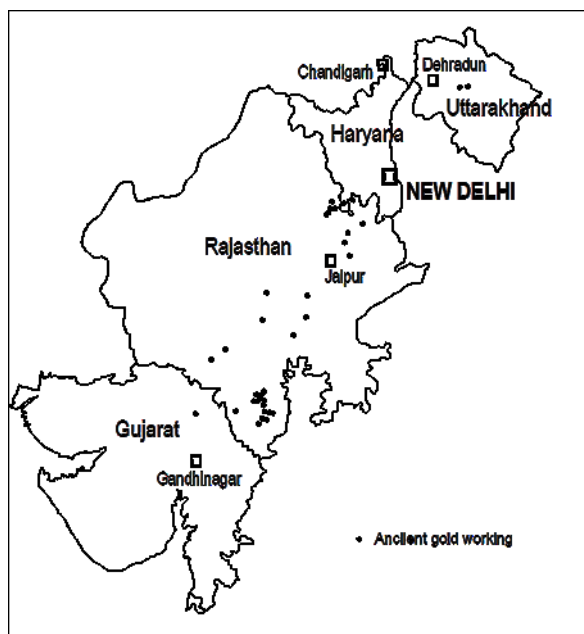


Fig. 2: Map of Gujarat, Rajasthan, Haryana and Uttarakhand States of India showing distribution of ancient mine workings for gold

4. Andhra Pradesh

Krishnan [21] recorded old mine workings for gold near Venkatampalle and Ramapuram in bluish vein quartz and near Sirasambedu in quartzite; and Roy [22] near Ramagiri, Buruju, bluish vein quartz and near Sirasambedu in quartzite; and Roy [22] near Ramagiri, Buruju, Kottapalli and Jibutil in greenish blue to white quartz veins within sericitic and chlorite phyllites. Krishnamurthy [23] reported such workings in the form of narrow trenches scattered over 7 to 8 mile long schist belt near Ramagiri. A group of old workings for gold have been reported near Chinnabhavi, Bhadrampalli, Kalagalle and Marutla Turpur areas and near Naggireddipalle [24, 25]. Old workings are also recorded within BIF for gold from Tsadukonda (two adits), Gandimudugu (30 x 3 x 4 m along with slag, retorts and pounding marks) and Mallaykonda areas [26, 25]; and four old workings suspected for gold near Penakacherla, all in Anantapur district. In Chittoor district the exploration revealed presence of gold up to 12 g/t in old working samples near Avulatippanapalli [27]; and up to 2.47 g/t near Palachhuru area in old prospecting pits (up to 15 x 10 x 12 m) within ferruginous micaceous quartzite. In Kurnool district narrow old workings and pits in amphibolite over a length of 1.1 km, pounding marks and dumps of crushed quartz are seen near Gavanikonda and Dona

[28]. Regional geochemical surveys also indicated gold anomalies in Gani-Kalva-Veldurti zone i.e. up to 1 g/t in Kalva old workings, 1.35 g/t stream sediments and 4.2 g/t in core samples. Ancient gold workings are also found near Chetlamallapuram and Peravali [29, 30].

5. Bihar-Jharkhand

The Chhotanagpur area had the reputation of being rich in gold deposits; details of which are given by Ball [31]. Krishnan [32] recorded presence of ancient mine workings for gold in quartz vein and mine dumps at Mayasara in Singhbhum district; areas near Rakhob i.e. Kambhar, Bairagi, Salka and Kandraja are quite rich. Ancient gold workings are also present near Kundarkocha (over 2 sq km), Suraigora, Rangra, Porojarna, Korriam and in Tamapahar and Bhaluk Khad hills of Lawa area with gold up to 13.4 dwt/t in samples [33]. Gold workings in quartz veins and quartzite near Sithaura (Patna district) and an adit near Porojarna (Singhbhum district) are reported by Roy [34, 35]. Similar workings are found in Sonapet valley [36]; Bhitardari and Hakegora [37]; Hurungda-Pondepai; Babaikundi [38]; Taramba [39]; Rungukocha and Pahardia areas (shafts) in West Singhbhum district where drilling has confirmed presence of sub-surface gold zones [40]. Recent investigation revealed ancient gold workings in Tilaitanr-Sobhapur area (Plate-1/3) in East and West districts, Singhbhum districts (www.gsi.gov.in).

6. Chhattisgarh

Gold is known to occur in the sands of Kotri nadi and nalas near Jarekurse (Kanker State) as per Krishnan [32]. The old workings of Sonakhan area, Raipur district within gossan and quartz veins have been reported for gold by Balasundaram [41]. Gold workings are recorded near Sonadai village and in Sonadehi Dongri (hill) in Bastar district. Nearly 100 workings are spread over one km in Sonadehi ridge in the form of shallow as well as deep (>50 m deep) pits and inclines (10 nos.); gold up to 20.7 g/t is recorded in grab samples from the underground workings [42, 43, 44]. In BIF the old workings are found in Bejhar-Tumrisur and Puro-Michigaon areas; and in Kumurkatta area [45] as pits and inclines; its mine muck showed visible grains of native gold confirming that the old workings were for gold.

7. Gujarat

On the basis of alleged occurrence of gold and silver in Rupen River near Kheralu, Mehsana district, panning of river sands was carried out which, however, did not reveal any gold or silver specks [46].

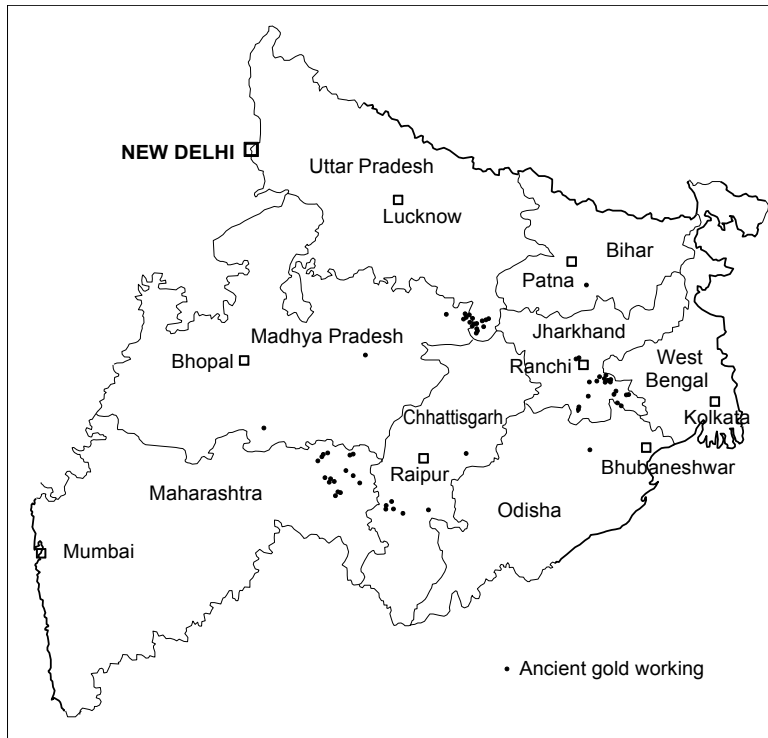


Fig. 3: Map of Maharashtra, Madhya Pradesh, Uttar Pradesh, Bihar, Jharkhand, Chhattisgarh, West Bengal and Odisha States of India showing distribution of ancient mine workings for gold

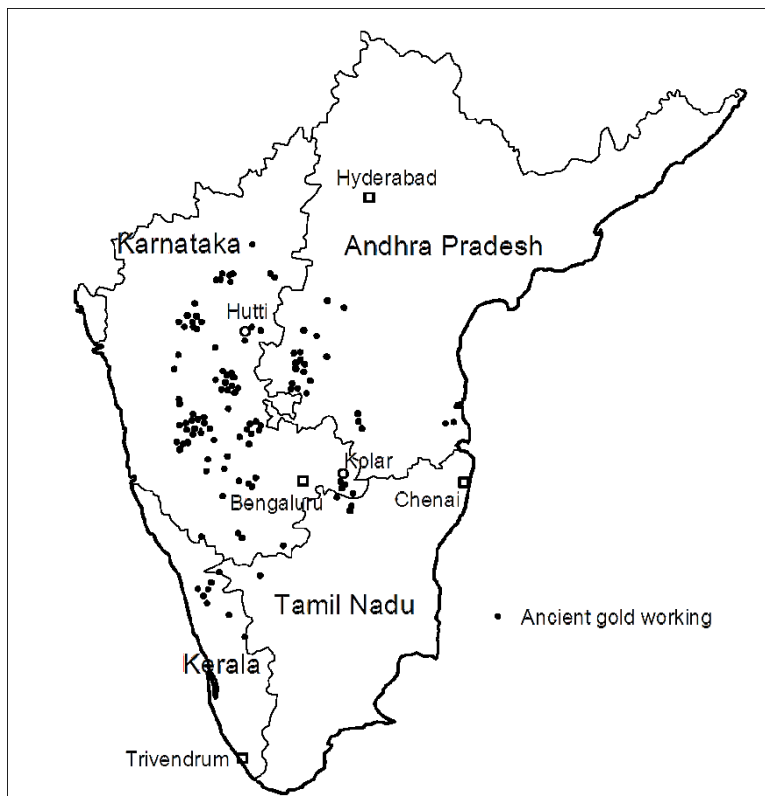


Fig. 3: Map of Karnataka, Andhra Pradesh, Tamil Nadu and Kerala States of India showing distribution of ancient mine workings for gold

8. Haryana

Ancient old workings for gold and slags are reported from near Ghataser, Manendragarh district; samples from the area analysed gold up to 2.75 g/t [47].

9. Karnataka

Captain Aytoun in 1852 reported presence of twenty two ancient workings for gold near Jalgurgood and Sangli/ Venkatpur; about 18 to 25 feet deep and 3 to 4 feet in diameter. The native knew nothing about them but said that gold was extracted from these in bygone days as per Maclaren [4], who himself recorded large number of old workings (pits and shafts) near Kabuliyakatti, some of which reached a depth of at least 300 feet; near Attikatti, Dindur, Nagati Basapuram and Jajkalgudda; in Hatti (Hutti) the workings reached up to 620 feet. He also identified rock grinding implements (rock breakers, anvils, pestles, mortars, in-situ depressions etc.) from Sangli, Nagavi and Nabhapur. West [48] reported gold in ancient mine dumps of reef quartz at Jalligeri (Dharwar district). Krishnan [32, 49] recorded ancient workings for gold in ferruginous quartzite in Mallapa Konda hill and Kangundi area near Bisnattam; the old workings were in a conical hill of blue quartz rock with bands of white quartz near Hirevedvatti; its hill wash contained rich gold. Ancient mine pits, trenches and quarries in BIF are recorded in the area [50]. Krishnan [51] also reported abandoned Jalgargundi gold mines near Lakkavalli in Chickmagalur district. Large number of ancient gold workings are present in Bellara, Ajjanahalli (Tumkur district, Plate-1/1), Kempinkote (Hassan district), Honnehatti (Honnegudda hill), Kudrekonda, Palvanahalli (Shimoga district), Kabligatti and Mangalagatti (Plate-1/7; Dharwar district) and Manglur (Gulbarga district) areas. The Ajjanahalli and Kempinkote workings are more than 600 feet long. In Kabligatti area some of the workings are 300 feet deep. The largest gold nugget found in 1907 in Kempinkote-Palvanahalli area weighed 4.5 ozs; and the richest lump of float quartz weighed about 15 lbs containing nearly 45 oz of gold [11].

Roy [52] recorded old workings for gold near Bangarakanahalli, Gollarhatti, Gudadarangawanahalli (Chitradurga district), Kalinganahalli and Honnebetta Hill near Nagmangala (Mandya district). Such workings are also identified near Belagumba, Jalgarnhalli and Yelwari in Hassan district; Etinahatti in Bellary district and Bellibetta in Mandya district [53]. Sampling from the old workings in the chert east of Kunchiganahalu (Chitradurga district) analysed gold up to 6 g/t [54]. In Chinmulgund area (Dharwar district) the exploration revealed gold workings (shafts, pits, inclines) over 3 sq km and significant auriferous zones at the contact of BIF and pyritic tuff. Several shallow old workings for gold occurring in an arcuate pattern are reported near Gollarahalli, Madehalli,

Vittalpura (shafts) and Kardihalli (shallow) in Hassan district [55, 56]. The ancient gold workings are known in Siddarahalli (adit, trenches, shafts), Kenchapur (shallow pits, incline, two shafts), Siddayahalli and Nandi (pits, 25 m deep incline, vertical shafts, narrow workings (Plate-1/6, 8; rich gold zones) areas in Chickmagalur district [57, 58, 59]. Mapping in NW extension area of Chitradurga schist belt revealed old workings, shafts and pounding marks over 600 m area; panning showed high concentration of gold specks near Honnemardi [57, 60].

Some of the ancient mining (deep shafts, adits and trenches up to 32 m long) sites are known for gold i.e. Hakkidonna and Hondonna in Honnegudda Hill and Bukkambudi in Chickmagalur district [61]. An ancient adit is recorded in acid volcanics near Chikkahonakani; and near Amarapur, Arbhogapur, Kilarihatti, Jaigadgudda, Chikbhergi, Naranhal (up to 210 m long trench and vertical shafts) and Wandalli (Plate-1/2) in Bijapur and Raichur districts [62]. Several old workings have been near Gurupur, Singanamane (Chickmagalur district) and near Tamadihalli and Honnuhatti-Hosuru (shafts, adits, trenches) in Shimoga schist belt [62, 63]. In Dharwar district geological mapping revealed a few ancient gold workings in BIF near Majjur, Doni Tanda and Kadkol; and shallow linear workings near Kotemaradi. Regional assessment of Chitradurga belt also revealed ancient gold workings near Basvanaguda, Gungarpenta, Kariyammanagudi (up to 500 m long) and Neralguda; along with pounding marks and four slag sites near Bellara in Tumkur district [63, 64]. Old workings near Huttur have been identified during geochemical exploration for gold in Kolar district [63]; and in Karjagi area, Dharwar district [65]. In Mysore district, the ancient gold workings are reported from Volageri and Amble south of Nanjangud. In Volageri area these occur in the form of pits and depressions (up to 75 x 25 x 5 m) over 300 m length; the underground sampling revealed presence of significant (2 to 6 m wide) gold (av. 6 g/t) zones [66]. In Gadag district rich gold zones are indicated in channel samples in Nabhapur old working (shallow pits, vertical shafts) area; gold is also confirmed in old workings (two clusters) of Sankatodak-Doni Tanda area [67]. In Chitradurga schist belt, channel sampling in the old working zones of Ramajogihalli analysed gold up to 3.7 g/t [67]; in Hosahatti area several old inclines (up to 20 m deep) and shallow workings, known for gold, are recorded [68].

Ancient gold workings from Hallekallu (up to 15 x 3 x 3 m, with visible gold specks in quartzite), Anesidri (shafts), Kachenahalli and Honnabetta in Chitradurga and Tumkur districts have been recorded recently [69, 70]. Presence of large number of ancient workings in BIF along with pounding marks and dumps of BIF and quartz are seen at Bangargatti ridge; the channel samples analysed gold up to 5.8 g/t. Recent drilling

revealed presence of rich gold zones in old working area of Yatkal in Raichur district. The old workings and pouncing marks for gold (up to 5 g/t in samples) are also seen near Ramapura and Dasapura over 6 km in Bellary district [71]. Trench samples from the old workings near Gaudikatte, Davangere district analysed high gold, which is confirmed by intersection of gold (up to 2.4 g/t) zones in drilling [72]. East of GR Halli one of the old pits was found to be an opening for two levels of underground development up to a depth of 30 m; and east of Honnemaradi the sediments are known to yield gold in panning; and large numbers of pouncing marks in granite are identified in Kanakuppe area [73]. Mohakul and Babu [74] mentioned that the find of two nuggets of gold each weighing 200 g in a white quartz vein, triggered the exploration in Honnemaradi area. In Hira-Buddini an old working (75 x 25 x 20 m) is located at the contact of acid and basic volcanics; recent exploration revealed it to be ancient gold working; and the area as high tenor gold deposit in Hutti-Maski schist belt [75]. Due to a broad alluvial cover in the area, only a few outcrops in the southeastern portion of the deposit were observed through an on sight visit and the use of a 1:5,000 scale map of the area. Based on this information four trenches were excavated (Fig2) revealing magnetite with volcanic Kiruna host rock. These units were separated and used in the GIS combination. Due to its importance this layer was given a weight of 50 [24].

10. Kerala

Maclaren [4]) had recorded that the Korumbars of Kerala are still digging the quartz leaders, crushing it and panning it to obtain gold. Presence of old workings and gold mineralisation were reported in BMQ in Nilambur valley by [76]. Ancient gold workings in the form of narrow trenches, adits, shafts along with underground extensions and occasional slag are recorded in quartz-magnetite granulite in Manjeri area, Malapuram district [77], and in Kappil and Mankada (trenches are up to 250 x 100 m in size) areas [78, 79]. Similar workings and slag dumps are found in quartz-magnetite granulite of Kadannamanna area [80]. Ancient workings (up to 70 x 10 x 6 m size) i.e. trenches, shafts and inclines are recorded in Nattukal prospect, Palakkad district for gold at the contact of BIF and granulite; the richer portion was mined out by ancient prospectors [81].

11. Madhya Pradesh

Krishnan [32] recorded that quartz was being crushed and panned to recover gold in Sonaghati area near Betul. Several vertical ancient mine workings (up to 8 m long, 7 m deep) possibly for gold are seen in parts of Sidhi district. Number of old workings, shafts, trenches and mine dumps are present in Imalia area, Jabalpur district where drilling revealed gold content up to 12.6 g/t in core samples [82].

12. Maharashtra

An old working along with mine dumps and clay retorts are recorded from near Tirka, the test panning revealed gold specks in the area. More than 1000 ancient workings (up to +20 m deep) and mine dumps are identified over a km strike length in Kitari area, Nagpur district; the sampling yielded gold up to 100 g/t and visible gold specks seen in drill cores bear testimony to the ancient gold mining activity in this part of the central India [83, 15]. Similar workings are identified in Dongarmunda, Kosari, Ranbori-Bhaonri, near Pular with quartz dump [83] and in Parsori area [84]. In Pular-Kosari area >300 such workings (up to 130 m x 30 m x 30 m size) along with grinding wheels, slag, mine dumps, old coins and a cave have been seen spread over one sq km area; gold is analysed up to 140 g/t in old mine dumps of Kosari area [84, 85].

In Bhandara district, ancient workings for gold are reported from Etawahi and Khairi area; and up to 4.52 and 20.26 g/t gold respectively is noted in samples [83]. Several old mines, slags and huge mine dumps of oxidised vein quartz (showing up to 5 g/t gold) are found in schist near Bhimsen Killa Pahar, Nyaharwani and adjoining areas [84, 86]. In Nagpur district, small exploratory workings (shallow pits) for gold are recorded in Ranmangli area [87]. Several parallel chains of ancient mine workings occur near Marupar; where drilling revealed presence of rich gold zones [88]. In Kolar area several ancient mine pits are located, the largest is locally known as 'Rakshas Gaddha'; the bedrock sampling revealed up to 15 g/t gold [15, 86]. In Rengatur area two linear zones of old workings, each extending for about 400 m, are seen; preliminary sampling analysed up to 4.2 g/t gold. During reappraisal for gold series of old workings are located in Tas-Kotalpur area within tuffs and mica schists [89, 90].

13. Odisha

Numerous old workings for gold are identified in lensoidal bodies of vein quartz in Gopur area, Keonjhar district; the samples yielded gold between 2.5 and 10 g/t [91].

14. Uttar Pradesh

During regional search for gold mineralisation a chain of ancient mine workings was located in border areas of Uttar Pradesh and Madhya Pradesh in central India near Chakoria (up to 1 g/t gold in samples), Sulkhan (up to 8.8 g/t) and Gurhar (up to 10.8 g/t); two workings are located near Sonkorwa (up to 15 m long, 4 m wide; up to 17 g/t gold), three near Amliha (up to 1.7 g/t), two near Budhadol (up to 2 g/t), three near Harrahwa (up to 8.3 g/t), five near Jamtihwa (up to 9.2 g/t), three near Khokhwa (up to 24.5 g/t), two near Bagdha (up to 1.6 g/t gold), one near Senduria (up to 5 g/t gold) and scattered pits near Tishiwa. The Sulkhan-Sonkorwa zone is more than a km long and 1 to 15 m

wide. The ancient mine workings for gold in Gurhar Pahar area occur in 4 to 5 sub-parallel zones [92, 93, 94].

During geochemical appraisal abandoned ancient mining sites for gold are found near Gurmura and Jharail in Sonbhadra district showing pits of variable sizes, shafts, trenches, inclines and stone grinding implements [95]. In Sona Pahari area (Plate-1/4) clusters of ancient gold workings (up to 8.6 g/t gold in samples) along with gold panning sites, crude grinding stones and grinders have been found spread over 2 km x 600 m area with one trench of 60 x 10 x 10 m size. The workings of Charam area are up to 20 x 10 x 2 m in size [96, 97, 16]. Ancient gold workings are also identified near Randhor and Biranbahra (up to 3 g/t gold in samples) near Gulaldih [98]; near Paraspani (up to 1.5 g/t), Kanhera (up to 1.5 g/t gold), Palsa, Gulariha and Garapathar and near Parasidhai with up to 3.5 g/t gold in samples [99]; The shallow pits found in Jugnera-Khajura area [100] showed gold (up to 2 g/t) and lead-zinc anomalies. Some of these sites with slag heaps are considered as iron smelting sites [2].

15. Uttarakhand

Alleged ancient mine workings for gold have been reported to occur in parts of Garhwal Himalaya e.g. Kimotha (Plate-1/5), Lameri, Tini-Koteshwar, Malari and Rudraprayag areas, etc. [101].

16. Rajasthan

Alleged ancient mine workings for gold have been reported from near Usri and Dhaulagarh in Jhunjhunu district, and near Sunarkuri in Ajmer district; the preliminary sampling, however, did not confirm it [102, 103, 13]. The ancient workings present in large number near Bhukia-Jagpura (Plate-1/9: Banswara district), Hinglaz Mata and Bharkundi (Plate-1/10; Dungarpur district) were the first to be confirmed for gold; visible gold specks and gold up to 70.6 g/t were recorded in gossan samples [104, 105]. Ancient gold panning sites and stone grinding implements identified in these areas form further supportive evidences for gold extraction in the past; and the grab samples of panned rejects analysed gold up to 11.75 g/t [18].

Detailed exploration has confirmed presence of significant gold resources in Bhukia-Jagpura area. Significant gold is also analysed in samples from ancient mine working areas known for copper viz. Matasula (up to 1.25 g/t), Gor Pahari (up to 3.2 g/t), Kalajoda (up to 1.8 g/t) in Alwar district; Jharka (up to 1.3 g/t), Kundli Hill (up to 9 g/t) in Banswara district; Amargarh (up to 1.8 g/t), Sawar-Bajta (up to 1.6 g/t), Devtalai (up to 1 g/t) in Bhilwara district; Dhani Basri (up to 3.19 g/t) in Dausa district; Dewal (up to 2.7 g/t), Hinglaz Mata (up to 48 g/t and native gold), Bhurkundi (up to 14.1 g/t) in Dungarpur district; Kolihan (up to 1.5 g/t) in Jhunjhunu district; Birantiya (up to 1 g/t) in Pali district; Gorla, Satkui (up to 1 g/t) in Sikar district;

Ajari (up to 2 g/t), Basantgarh (up to 3 g/t), Pipela (up to 2 g/t) in Sirohi district; Parsola (up to 2.2 g/t), Harmatia (native gold specks), Isarwas (up to 7 g/t), Kevda (up to 3.2 g/t), Lohagarh (up to 2 g/t), Manpura-Sanjela (up to 4.8 g/t), Dugocha (up to 10 g/t), Rajpura (up to 6.5 g/t) and Vasu (up to 2.16 g/t) in Udaipur district. Extensive slags, pestles and mortars are located in Manpura-Sanjela area; the slag analysed up to 1.33 g/t gold [106, 107, 108, 109, 110, 17, 19].

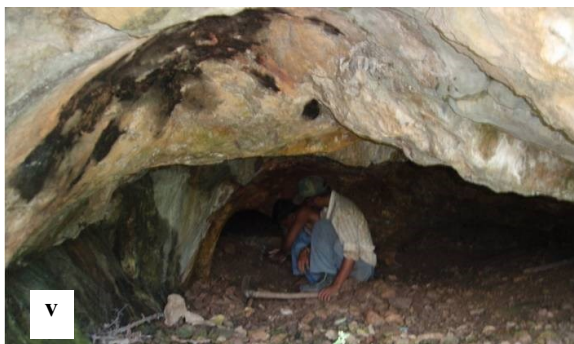
17. Tamil Nadu

King [111] recorded presence of ancient mine workings in Chullaymullay Mountain near Dayvallah for gold; and mentioned that the Malabar district was famous for gold since time immemorial. Presence of gold workings in Kotagiri (Nilgiri district) is recorded by Chatterjee [112]. Extensive workings (up to 25 feet deep) for gold are reported by Krishnan in 1951 from Hadabanatta area (Coimbatore district) where visible gold was seen in debris after crushing and panning of the material. Ancient gold workings are also identified near Sakalagunta and Bangaragunta in Bargur area, the samples analysed up to 9.5 and 8 g/t gold respectively [78]. Very old trenches also exist in Addakonda sector (gold up to 2.35 g/t in bedrock samples) in Dharampuri district [68].

18. Ancient gold mining activities in soft rock terrain

These include areas of laterite and Quaternaries showing presence of ancient underground workings, hence, are different from those of riverine sand or gravel washing sites as well as the hard rock terrain. Dey [113] recorded numerous ancient gold workings as shafts with 6 feet diameter in Quaternary sediments in Jashpur area, Raigarh district, Chhattisgarh State; the depth of which reached up to 60 feet. The area, at places, looked like a gigantic rabbit warren due to presence of large number of shafts dug over small area. The gold was found in various soils, blue, red and yellow clays full of gravels and resting on granite; the gold bearing gravel or placer stratum was not more than one foot in thickness. Dhoundhial [114] recorded that the ancient gold workings of Manjeri area (Malapuram district) in Kerala are located within laterite. In J. & K. State the old workings for gold are identified near Bikudo, Leh district in alluvial fans and terraces on either side of the Faston nala [97]. In Parveli area, Bastar district about 50 ancient shafts, 12 pits and an incline have been found occurring in a series over laterite mound [82]; the diameter of shafts, which at places are interconnected, was 0.8 to 1 m with depth more than 6 m. Large number of old mine workings (50 pits and 9 shafts) are observed in laterite over 800 m long zone in Gurpher area of Kotri rift zone, Kanker district [88].

Plate-I: Photographs of some ancient gold mines located in different parts of India





Explanation to **Plate-I** Photographs

- i. An ancient gold mine in BIF, Ajanahalli prospect, Tumkur district, Karnataka
- ii. Ancient gold mine in Wandalli prospect, 10 km east of Hutti Gold Mine, Raichur district, Karnataka
- iii. An old mine shaft in Tilaitanr gold prospect, Singhbhum district, Jharkhand
- iv. A linear ancient gold mine in Sona Pahari prospect, Sonbhadra district, Uttar Pradesh
- v. An old mine working for gold in Kimotha area, Chamoli district, Uttarakhand
- vi. An old mine for gold located at 1.5 km north of Kenchapura, Shimoga district, Karnataka
- vii. An ancient mine in Mangalagatti gold prospect, Dharwar district, Karnataka
- viii. A deep old mine shaft for gold in Kenchapura area, Shimoga district, Karnataka
- ix. An opencast mine for gold in Bhukia prospect, Banswara district Rajasthan
- x. An ancient incline for gold near Bharkundi area, Dungarpur district, Rajasthan

19. Time period of the ancient gold mining activities

Gold is an integral part of the Indian culture/Hindus since long past as mentioned in their religious texts e.g. Veda, Puran, Upanishad and epics (Ramayana and Mahabharata), etc. Allchin [115] postulated that the discovery of reefs for gold during the Neolithic period was in Deccan area; now established between the end of 3rd millennium BC and the first half of the first millennium BC. Apart from Neolithic phases, the archaeological studies have revealed presence of gold ornaments from Chalcolithic sites, PGW levels, megalithic burials and Early Historic sites [2]. The antiquity of gold has been traced back to Pre-Harappan period (2nd half of the fourth millennium BC) as per the artefacts (beads of gold sheet with tubular perforations) found near Multan, now in Pakistan [1]. Nature of gold and gold ores, its impurities and metallurgical processing etc. was well known in early Mauryan period (4th century BC to 2nd century AD) as detailed by Kautiliya in Arthshastra [116].

Carbon dating of wood samples from Hutti area indicated that the gold mining activity began 4000 years ago supporting the above age bracket [117]. Wooden logs from the Inghadhah and Kunchiganahalu old workings also showed a range of 2070, 1820 and 1300 (+/- 100 years) ages by C14 dates [118]. It is in the history that Darius, the Persian king (480 BC) received tribute from Indians in the form of gold dust

[119, 2]. On the basis of rock edicts several ancient gold mining sites have been equated with the period of King Ashoka [120]. A thin piece of gold along with stone moulds found from Champanagar near Bhagalpur belonging to C.500 to 1st century BC [121] indicates use of gold in Eastern India before Christian era. Rock carvings and scriptures found in the caves close to ancient gold mines of Kosari (Nagpur district) in Central India belonged to '2nd BC or earlier' age [84, 85]. A few copper coins recovered from Pular area, Maharashtra carried inscription of 892 Arabic Hijri years in Persian language, equivalent to 1472 AD [15]. In Chinmulgund area (Dharwar district) the ancient gold mines were operative during the period of Vijaynagar kingdom and Tipu Sultan [11]. The gold mines of Hadabanatta were said to be active during Hyder Ali's time [122] and those of Ramagiri (A.P.) area belonged to the period of Tipu Sultan [23]. All these are in support of the second period of the history of gold mining.

20. Discussions

Apart from the incidence of gold in veins and reefs of quartz, its significant amount is contained in sulphide ores of copper and uranium occurring in different parts of India. Hence, some of the ancient workings of such areas also would have acted as gold-copper mines for the ancient prospectors particularly in areas where the gold content was considerably high. This view is strengthened by the fact that significant

amount of gold is presently being recovered from such sulphide ores and imported copper concentrates as by-product (secondary gold) during refining in smelters at Tuticorin in Tamil Nadu, Khetri in Rajasthan, Dehag in Gujarat, and Ghatsila and Jaduguda in Bihar [13, 123, 124, 125, 126]. Law [127] has suggested that the gold artefacts found in Harappan sites of Indus Valley Civilisation could be the by-product of Khetri or Baluchistan sulphide ores.

The significance of the identification of ancient gold mining activities is apparent from the fact that 'most of the modern gold mines of South India are located on the ancient gold workings' viz. Hutti (main reef), Kadoni, Wondalli, Chinchergi-Topaldoddi, Uti, Mukangavi (Manglur), Maski, Ramaldinni, Udbal Sanbal, (Sanwal) in Hutti goldfield; Bisnattam in Kolar goldfield; Attikatti, Kabulyakatti, Mysore mine, Sangli, Hosur in Gadag goldfield; Dod Burju (Chinnabhavi), North and South Jibutil in Ramagiri goldfield; Alpha/Victoria/ Nadhgoni, Harewood, Solomon, Rousdenmalai, Phoenix, Richmond and Glenrock in Wynad goldfield; Ajjanahalli, Jevanhalli and Bellara in Chitradurga schist belt [3]. Search for the ancient areas of gold mining activities, therefore, should continue.

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