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GEM–MINERALS IN PRE-MODERN INDIA

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This paper is a comprehensive review on gem minerals in pre-modern India. Starting with the travellers' accounts during the medieval period and the gem treasury of the Moghuls, this treatise presents itemised discussions on specific gem minerals such as pearl, coral, quartz, agate, corundum, zircon, garnet, beryl, etc.

Lastly, there is a special section on Indian diamond mining in the pre-modern era. Some Arabic/Persian terms for gems used in medieval India are tabulated. The causes for the decline of the medieval gem industries are analysed.

INTRODUCTION

A comprehensive report on minerals and metals – including gem minerals – in ancient India was prepared and submitted to the Indian National Science Academy (INSA)[1]. A summary on Gems and minerals[2] included the nature of evidences about the antiquity of their uses, narrative from Mehargarh to Taxila, specific discussions on some selected gem minerals (and metalliferrous ores) and lastly the need for further studies and research on the subject.

It was emphasized that the subject is a continuing one in the annals of history, and the demarcation line between the 'ancient' and 'medieval' period in India (1200 A.D. is the conventional date) is bound to be arbitrary. Instead of 'medieval' we prefer the term 'pre-modern' to indicate the 19th century vantage point looking back-wards to find out what India had achieved in the field of gem minerals during the period from sixth to eighteenth century.

This chapter is divided into the following sections: (a) travellers' accounts of Indian gems (b) the gem treasury of the Moghuls (c) itemised discussions on specific gem minerals such as pearl, coral, crystalline and chalcedonic quartz, agate and carnelian, corundum, ruby and sapphire, zircon, garnet and beryl, etc. (d) and special section on Indian diamond mines in the pre-modern era and lastly (e) concluding remarks.

TRAVELLERS' ACCOUNTS OF INDIAN GEMS

India's traditions in ancient and medieval gems are authenticated not so much by

archaeological evidences as by the travellers' accounts. Valentine Ball has collated some of these accounts.[3-5]

Pliny in his *Historia Naturalis* (77 A.D.) had given an extra-ordinary amount of information regarding precious stones and metals, a large proportion of them being of Indian origin. He referred to Indian *adamas* (diamond), *smaragdus* (emerald), beryl, opal etc. *The Periplus of the Erythraean Sea* (80-89 A.D.?) mentioned the export of Murrha, the cups and vases of carnelian and agate. The sardonyx mines of Ptolemy (140-160 A.D.) are probably identical with the famous carnelian and agate mines of Rajpipla or Ratanpur. Ptolemy referred to diamond mining on the Adamas river, the location of which has been widely debated. Colonel Yule identified this with Brahmāni in Orissa, but it could be Mahānadī.

During Emperor Justinian's time (6th century A.D.), the Persians became rivals of the Romans at the Indian ports, and this has been described by Cosmos, an Egyptian merchant. During the advent of Islam, the Arabs wrested the Oriental trade of gems from the Persians. One of the contemporary Arabic works bears the title: *Meadows of Gold and Mines of Jewels.*

The outstanding 13th century Persian work on precious stones by Mahomed Ben Mansur was translated into French by Joseph Von Hammer (Mines de 1' Orient, vol vi), an English version of which was published (Asiatic Journal, vol. ix, 1820, p. 345). Although Ben Mansur mentioned seven varieties of diamond, his knowledge regarding the geographical location of the Indian mines was very vague: "it is found probably in the *Yakut* mines of the Eastern India". He described six-varieties of *Yakut* gems – and many subdivisions including sapphire, ruby, emerald, topaz etc., emphasizing on their hardness. Ben Mansur described how an earthquake, during the time of the Caliphate of the Abbasides, led to the discovery of balas ruby mine in Badakshan embedded in white limestone matrix. He also referred to the popular usages of turquoise, rock crystal ('which could be melted like glass and coloured so as to imitate *Yakut*, *lal* or emerald') amethyst, emerald, jade, jasper etc. Ben Mansur described Abu Rihan Al-Biruni's water – displacement experiments to determine specific gravities of precious gems[6].

Alberuni had wirtten about Indian gems, and by the eleventh century when the treasures of north India were either plundered by the Muslims or taken to the south for safety, the empires and temples of South India became store-houses for precious metals and gems.

The Muslim loot was extended to South India. Hazrat Amir Khusrau accompanied Malik Naib, Alauddin Khilji's army general in the 1310-1312 A.D. military expendition to South India and described the colossal treasure of gold, emerald and other gems which had been collected during the earlier period of Ancient India[7]. When the fort of Warangal was attacked, Rai Laddar Deo (Pratāpa Rudra II) had to give up his treasures and jewels. Khusrau described (Ref. No. 7, pp. 76-77):

"The boxes carried by the elephants were full of valuables and gems, the excellence of which drove the onlookers mad. Every emerald (*Zabarzad*) sparkled in the light of the sun.... The corundum/sapphire (*Yakut*) dazzled the eye of the sun. The cat's eye (*ainul hirrat*) and the cock's eye (*ainul dīk)* were so brilliant. The lustre of the rubies (*lāl*) illuminated the darkness of the night. The emeralds had a fineness of water that could eclipse the lawn of paradise. The diamonds (*ilmās*) would have penetrated into an iron hearth like an arrow of steel. The other stones were such as the sun blushed to look at them. As for the pearl, you would not find the like of them, even if you kept diving into the sea through all eternity. The gold was like the full moon of the twelfth night; it seemed that in order to ripen it, the *alchemist*, the sun, had lighted its fire, and the morning had blown its breath, for years.... The Arīz-i-Mumālik (gemmologist) divided the jewels into 'genus' and 'species', 'class' after 'class', and had everything written down.... Among them was a jewel (Koh-i-Nūr?), unparalleled in the whole world".

The sack of the golden temple of Barmatpur was similarly described (Ref. no. 7, pp. 102-107):

"Its roofs and walls were inlaid with sparkling rubies and emeralds, and after gazing at them, red and yellow spots came before the spectator's eye... The heads of the idol-worshippers came dancing from their necks. The golden bricks rolled down and brought with them the plaster or sandal-wood; the yellow gold became red with blood, and the white sandal turned scarlet. The foundations of the temple, which were mines of gold, were dug up, and its jewelled walls, which were mines of precious stones, pulled down... There were five hundred *maunds* of precious stones".

Malik Naib reached Delhi in 1312 A.D. with 612 elephants, 20,000 horses, 96,000 *maunds* of gold (the figure seems absurd), many chests of jewels and pearls. The old men of Delhi declared "No one remembers such treasures and spoils brought ever to Delhi" (Ref. no. 7, p. 117)

Alauddin Khilji's loot has been authenticated by the Jaina scholar Thakkura Pherū born around 1270 A.D., who was probably an assay – master in Alauddin's court[8]. Pheru saw with his own eyes the vast collection of gems – like the ocean – in the treasury of Alāuddin – the emperor of the Kali age, and also witnessed the examination of the gems by the experts[8] (Rayana-parikkhā, 1.4-5).

In his book, Pheru followed the framework of Indian *ratnaśāstra* or gemmological literature. However he described new varieties and sources of ruby, sapphire, emerald etc. The contemporary gem trade and tariff prices were described. In a separate section (7.103-105), Badakshan spinel or balas – ruby, Yemen carnelian (*akīk)* of deep red hue and the beautiful blue turquoise of Nishapur and Al-Moussul were mentioned as gems imported from Persia.

Ibn al-Afkānī, an Egyptian (who died in 1348 A.D.) and a contemporary of Pheru

wrote in his Arabic work on gemology *Nachb al.*. Gawahir, about the Indians' preference for white and yellow diamonds, the beautiful diamond specimens in the court of Qutbuddin Mubarak (1316-1320 A.D.) and the seven varieties of *Yāqūt* or ruby – the best *rummānī* variety having the colour of the fresh seed of pomegranate. Al Ta'ālibī enumerated the best contemporary sources of different gems: turquoise of Nishapur, ruby and sapphire of Sri Lanka, carnelian of Yemen, garnet of Balkh and the spinel of Badakshan[9].

Marco Polo, the famous Venetian traveller of the thirteenth century, reported diamond trade going on through the ports (such as Motupalle) of the Guntur district, the big stones going to the Indian kings and the great Khan, and 'the refuse of the finer stones of Europe'. Aftter the rains the beds of torrents were searched for diamond, wrote Marco Polo.

He referred to other precious stones, the trader of balas rubies and lapis lazuli of Badakshan. Enormous amounts of gold were being stored by the South Indian princes. Copper, gold and silver were being imported into Malabar and Cambay from the eastern countries of Burma, Malayasia, Indonesia etc. These treasures in their turn were plundered by the Muslim invaders form the northern India. Muhammad Bin Tughlak loaded hundreds of elephants with the precious spoils of Hindu temples.

Ibn Battutā wrote in his *Travels in Asia and Africa (1325-1354)*, about pearl fishing of incredible magnitude going on at Ramnad (Adam's bridge) in Tamilnadu and also sapphire mining in Sri Lanka. Ferishta described in 1425 the long-deserted diamond mines in Madhya Pradesh probably those of Wairagarh – and the great wealth possessed by the kings of South India in the form of precious stones and bullion. For two centuries, there was a resurgence of Hindu imperial culture at Vijayanagara (1350-1564 A.D.), the economic history of which has been narrated by Burton Stein (Ray Chaudhuri and Habib[10a]). The gold and diamond treasures of the Vijayanagara empire were described by the Venetian Nicolo Conti (1420 A.D.) mentioning washing procedures for diamonds executed in the bed of rivers.

Odarodo Barbosa reported in 1519 the gem mart at Vijayanagara transacting jewels – from Burma, Sri Lanka, Lower Krishna valley-such as rubies, spinel, diamond, sapphire, topaz, turquoise, hyacinth, emerald, etc. Barbosa reported the sources and full account of the values of these gems. He also described how the foreign Muslim (Moors) were conducting pearl-fishery and trade in Calicut and other parts of Malabar without interference from the king. Gradually they faced competition from the Portuguese and the Dutch.

In the year 1563, Garcia da Orta, in his famous work on the Simples and Drugs of India written in Portuguese mentioned four large Indian diamonds, one of which had the 'size of a small hen's egg' and was kept at Vijayanagara. The others weighed 150, 175, and 312 carats. Garcia da Orta mentioned that at Vijayanagara the big gems weighing more then 30 mangelis (750 carats?) were handed over to the king. Even the

tailings were rewashed to recover additional quantities of diamond. The first discovery of diamond in Brazil was reported at this time although commercial processing in that country started around 1728 A.D. ending the Indian monopoly in this gem. Hyacinth and garnet were found in Calicut and Cannanore, garnet being distributed through the whole of Cambay and Balaghat, the latter also producing imitation emerald made of glass.

In Golconda, Qutbshahi kings used to collect excellent workmen, and a number of workers on precious stones and kept them busy at the *Kārkhānās* to do any work for anybody else[10b].

Ralph Fitch and his companion Newberry left an account in 1583 A.D. about the gem mart at Belgium, dealing with diamond, ruby sapphire and many other precious stones. Their companion, one William Leades, a jeweller, stayed behind at Cambay to serve the local king. In 1590, Abul Fazl, the author of Ain-i-Akbari, wrote on the diamond mine of Wairagarh and gold-washing in the rivers of Kashmir.

Benedict Goez reported in 1602 the production of jade in Kashgar, 'a certain shining marble, which for want of a fitter name, Europeans call jasper'. Vessels, ornaments made of jade were imported by Moghuls in India. Nephrite, jadeite and chloromelanite – all the three varieties of jade available in the regions of Kashghar, Yarkand and Khotan used to be processed by the early Buddhists of Central Asia. Later, this trade flourished under Ulugh Beg in Central Asia. Jahangir became a great patron of Timurid work-manship in jade during the early part of the seventeenth century[11].

In 1602-03, the Portuguese traders took away from India not only indigo, pepper and other spices but also some quantities of carnelian (*laqueca*) and precious stones like diamonds and pearls. During 1618-19 the English trade from Surat showed purchases of precious stones from India (bulk of it was of course indigo and calico). The Dutch traders also purchased some Indian (Golconda) diamonds in the 1620's. (These data have been provided by W.H. Moreland in his treatise of economic history 'From Akbar to Aurangzeb').

De Boot's work in 1609 and John Ogilby's writing in 1673 recorded some valuable information about Indian gems and mineral resources, but their data were tentative and not always reliable. Tavernier (1665-1669) mentioned 'excellent gold' from Kashmir rivers and 'not so good' gold and also silver coming from Assam. His notes on tin ores from Malaysia, ruby from Burma and sapphire from Sri Lanka did not provide accurate details about their sources.

Tavernier described Goa as the place where formerly (before his time), 'there was the largest trade in all Asia in diamonds, rubies, sapphires, topazes and other stones – there was also at Goa a large trade in pearls'. The miners and merchants used to go there, eluding their kings, to fetch the best prices for their best gems (Ref. no. 5,

p. 95). The Portuguese monopoly of the international trade in Goa declined during the last decade of the sixteenth century with the ascendancy of the marine power of the Dutch.

The Gem Treasury of the Moghuls

The Moghul dynasty consolidated the gem treasures of the Pathan rulers. It is said that 'Babar's diamond' was received (1526 A.D.) by his son Humayun from the family of Raja Bikramajit, when he took possession of Agra. It had been earlier acquired from the Raja of Malwa by Alauddin in the year 1304 A.D. Erskine and King have identified Babar's diamond, weighing according to Ferishta 8 mishkāl or 186 English carats, to be identical with the famous *Koh-i-Nūr* now in the British throne. Valentine Ball however refuted this identification[5], and suggested that Babar's diamond is the 186 carat, flat *Daryā-i-Nūr* now in the Shah's treasury in Teheran.

Akbar was the first Moghul who organised a 'treasury for precious stones' as described by Abul Fazl (Ain 3). The foundation of the treasury rested on 'the four pillars' of an intelligent, trustworthy treasurer, a zealous *dāroghā*, a band of skilful jewellers and a retinue of assistants. Rubies, diamonds, emeralds, red and blue yaquts were categorised under 12 classes and pearls into 16 classes. The value of the jewels and the charges for boring pearls were recorded[12].

Jahangir was a great lover of gems, particularly diamonds and jades. By the time of Shah Jahan, the treasury had a huge stock of diamond, emerald, lapis lazuli, ruby (some inscribed), sapphire and also rosary, necklace and ornament studded with them[13]. After imprisoning his father, Aurangzeb wanted to possess the entire collection, when Shah Jahan sent back the word that he would pound all the gems in a pestle and mortar rather than part with them. Aurangzeb ascended the throne with only one oriental topaz on his cap, and had to wait for his father's death before gaining the entire treasure of jewels.

Tavernier was allowed to examine Aurangzeb's jewels on the 2nd of November 1665. Being a jeweller and gemmologist himself, his account is of great importance.

The first piece that he was allowed to examine in his hands was the 'Great Mogul' diamond, a round rose, very high at one side. When Mir Jumla, who betrayed the King of Golconda, his master, presented this stone to Shah Jahan, the stone weighed 787 carats. It had been discovered in the Kollur mine in 1656. The wasteful grinding treatment to it subjected by a Venetian named Hortensio Borgio, reduced it to 268 English carats and this is how Tarvernier found the piece in Aurangzeb's collection.

Tavernier described and drew the shapes of this 'Great Mogul' and seven other piece which he saw in Aurangzeb's treasury (Ref. No. 5 pp. 96-99). Their weights were recorded by him. One of them weighed (137 carats) and looked like the Austrian

Grand Duke of Tuscany's diamond. Another one, a 230 carat table diamond, had been seen by Tavernier once before at Golkonda (1642 A.D.) 'in the possession of merchants', and valued by him at 5 lakhs of rupees.

Tavernier also saw a jewel set with 12 diamonds, the central one being 'a heart-shaped rose of good water'. There was another jewel set with 17 diamonds.

Aurangzeb had a large collection of pearls, the largest being a pear-shaped one, a little flattened on both sides, weighing 70 ratis or approximately 60 carats.

There were two chains, one of pearls and rubies of different shapes pierced like the pearls; the other of pearls and emeralds, round and bored. All the pearls were round and from 10 to 12 ratis each in weight. Tavernier described:

"In the middle of the chain of rubies, there is a large emerald of the old rock (perfectly crystalline) cut into a rectangle and of high colour, but with many flaws. It weighs about 30 ratis. In the middle of the chains of emeralds there is an oriental amethyst (actually purple sapphire), a long table, weighing about 40 ratis and the perfection of beauty" (Ref. No. 5 p. 318)

Tavernier also described the 158 carat oriental topaz (actually yellow sapphire) of octagonal shape which Aurangzeb wore on his cap during coronation, several cabuchons (polished but not cleaved) of ruby and balas ruby etc. There was a ruby two inches square, bearing the name of Jahangir which was taken to Persia and later ended up in Ranjit Singh's collection.

Aurangzeb was the proud possessor of all the gold and jewels worth 4 million pounds owned by Dara Shikoh and a larger amount of treasure possessed by his father. In addition, he had seven magnificent thrones, one wholly covered with diamonds, the others with rubies, emeralds or pearls.

THE PEACOCK THRONE:

The principal throne was 6 feet long and 4 feet wide. The four bars which supported the base of the throne were inlaid with gold and enriched with numerous diamonds, rubies and emeralds. The middle of each bar was decorated with ornamental square cross constituting of either one central ruby with four emeralds round it, or one central emerald with four rubies on four sides. The intervals between rubies and emeralds were covered with diamonds. There were similar decorations all round the throne. Tavernier counted 108 rubies, all cabuchons, weighing 100 to 200 carats each and 110 emeralds weighing 30-60 carats each on the great throne. Tavernier wrote:

"The underside of the canopy is covered with diamonds and pearls, with a fringe of pearl all round, and above the canopy, which is a quadrangular-shaped dome, there is a peacock with elevated tail made of blue sapphires and other coloured stones. The

body of the peacock is made of gold inlaid with precious stones, having a large ruby in front of the breast, whence hangs a pear-shaped pearl of 50 carats or thereabouts, and of a somewhat yellow water. On both sides of the peacock there is a large bouquet of the same height as the bird, consisting of many kinds of flowers, made of gold inlaid with precious stones.

"In my opinion the most costly point about this magnificent throne is that the twelve columns supporting the canopy are surrounded with beautiful rows of pearls, which are round and of fine water, and weigh from 6 to 10 carats each. At a distance from the throne, the two umbrellas fixed on either side are covered with diamonds, rubies and pearls".

The cost of the famous throne has been variously estimated as 4 crores of rupees (Bernier) to 10 crores of rupees (Tavernier). The throne was taken to Persia by Nadir Shah. Lord Curzon believed that the Peacock Throne, now in Teheran, priced at 2.6 million pounds is a re-constructed one, utilising the original materials.

Nadir Shah also took away in 1739, the entire (70-80 million pounds worth) gem treasure at Delhi, including the 268 English carat 'Great Moghul' diamond. He named the celebrated piece as *Koh-i-Nūr* or the Mountain of Light. When this gem reached Ranjit Singh of Punjab in 1813, through a long chain of violent events, it weighed 185 carats. Valentine Ball has explained this discrepancy of 83 carats in terms of mutilations sometime during the period 1739-1813. When the gem was taken from Lahore to England in 1849, Mr. Tennant, a gemmologist observed in the piece 'two large cleavage planes, one of which had not even been polished, and had been distinctly produced by fracture' (Ref. No. 5, pp. 342-343).

Exactly a century after Nadir Shah's plunder of Delhi, occurred the demise of Ranjit Singh. On his deathbed, he expressed a wish that the diamond, then valued at one million sterling, should be sent to the Jagannātha (temple) at Puri, but this intention was not carried out. Through Delhi, Teheran and London it has remained as the property of the usurpers.

The huge collections of gems and jewelleries, looted from India, adorn the museums of London and Teheran. The chests 'filled with gold, silver, diamonds, pearls and emeralds from the Moghul's treasury' are now in the Teheran Museum. This has been characterised by a Curator of the Smithsonian Institution as 'perhaps the greatest jewel treasury of all times'.

When Timur plundered Delhi in 1398-1399, he took away many gems including a ruby which was later celebrated as Timur's ruby. It came back to Jahangir, a descendant of Timur, was agian taken away by Nadir Shah, back to Rajnit Singh and finally to the Crown in England. Koh-i-Nūr, several other diamonds, Timur's ruby are now the possessions of the latest plunderer of the Indian jewels, the British royalty.

Discussions on Specific Gem Minerals

Let us now record some of the pre-modern or medieval observations on specific gems in India, avoiding both the treatise on the ancient period which we have done before extensively[1], as well as the modern or the twentieth century scenario. First, we would take up two soft gem materials which are of organic nature and hence of non-mineral origin: pearl and coral.

The pearl fisheries in India flourished early in the ancient period. In the seventeenth century, Tavernier reported the trade going on in the Gulf of Persia as well as in the gulf separating Sri Lanka and South India. He observed that the oysters of the Manār Strait open up themeselves, spontaneously, 'five or six days sooner than those of the Gulf of Persia, because the heat is much greater at Manār'. The latitudes in the gulf between Sri Lanka and India are between 8-9°, whereas, that in the island of Baharein is 27°. Tavernier also corrected the earlier held, erroneous impressions 'that the pearl originates from the dew of heaven, and that but one is found in each oyster'.

The pearl-fishing in the Manār used to take place twice a year during March-April and then August-September ('the heavier the rainfall, the better the pearl-fishery'), and the sale lasted from June to November. Tavernier wrote:

"It should not be supposed that a great profit is earned by those who fish for pearls; for if the poor people who engage in it had anything else to do, they would leave the fishing, which merely saves them from dying of hunger, ... Those who fish like to know beforehand whether it will pay..... The people of Manār are better fishers, and remain for a longer time under the water than those of Bahrein; they do not place any clips on their noses nor cotton in their ears to keep the water from entering, as is done in the Persian Gulf" (Ref. no. 5, pp. 91-94). The pearls at Manār usually 2-4 carats in weight, were 'the most beautiful both as regards water and roundness, of all the fisheries'.

The Portuguese 'used to protect' the poor fishermen of Manār from the Malabaris, but that was before Tavernier's time, when the Dutch displaced even the Portuguese and extracted not only the 'protection levy' but also one day's catch (in a week) from the fishermen. The large trade of pearl and other precious gems at the Portuguese Goa had become, during Tavernier's time, a thing of the past.

The pearl trade prospered under the Dutch. The Indians liked the round as well as the 'baroque' (irregularly shaped) pearls. The sketch of the largest pearl which Tavernier saw and drew (the 50-carat, yellowish, pear-shaped one, hanging from the neck of the peacock in the celebrated throne) looks like an oblong hanging water droplet. Finally, Tavernier made the following interesting comment:

"All the Orientals are very much of our taste in matters of whiteness, and I have always remarked that they prefer the whitest pearls, the whitest diamonds, the whitest

bread, and the whitest women". (Ref. no. 5, p. 91)

Tavernier gave some details about coral fishing and trade during his time. He mentioned seven areas in the Mediterranean Sea region where coral fishing was being done: three areas around the coast of Sardinia-Alghero, Boza, St. Pierre, – fourth, the island of Corsica, coast of Sicily near Trepani, the coast of Algiers and the seventh, the north coast of Tunis. Tavernier noted that whereas coral did not rank among precious stones in Europe, the people in the East preferred this, 'one of the most beautiful of Nature's productions', to precious stones. Tavernier observed: "It is much to be wondered that the Japanese give so much money for a fine piece of coral..... The common people wear it and use it as an ornament for the neck and arm throughout Asia, but principally towards the north in the territories of the Great Moghul (Aurangzeb), and beyond them, in the mountains, of the Kingdom of Assam and Bhutan" (Ref. no. 5 pp. 104-107).

A small town named Lantegree in Maharashtra was a great centre of coral-polishing in the early seventeenth century. The preference of the Indians and other Asians for coral was manifest even during the ancient period, and the *reason* for this preference has been the subject of many dissertations. Many travellers like Pliny and Marco Polo attributed the preference for coral 'to the way its tints adapt themeselves to set off a dark skin (of the Asians)'. One of the reasons could be a religious antecedant. The reddish yellow coral was like *rudrākṣa* berry, the eye of the Śiva and a symbol of renunciation and spirituality. It must have gained popularity during the Tantric period of Hinduism and (Mahāyāna) Buddhism. The 'ornament for the neck' used by the common people was a rosary of coral beads, which were counted during prayers.

The Indian tradition of jewelleries made of rock crystal is very ancient but not well-documented. The present author has suggested[14] that the South Indian generic term *vel-ur* stood for white crystal town and gave rise to the more popular terms of *veluriya* or beryl and *veloari* or rock crystal.

There was widespread use of chalcedonic and crystalline quartz (in ancient India), which were available in the rocks near Tanjore and the estuaries of Krishnā and Godāvarī. Ball reported (Ref. no. 5, p. 502) that the lapidaries at Vellum (latitude 10°43' and longitude 79°12') had skilled workers in different varieties of rock crystal, such as the ordinary pellucid quartz, smoky quartz, cairngorum and amethyst. The last was brought from Kangiam in Coimbatore, and the rest derived from Cuddalur (tertiary) conglomerates. The ornaments made were chiefly of broach stones cut in the brilliant, rose and other patterns. Godāvarī district, Hyderabad state and Sambalpur district of the Central Provinces also provided brilliant rock crystals.

Aurangpur of the Gurgaon distrct, 15 miles south of Delhi, had Aravalli quartzites from which quartz crystals were extracted, and these might have been used for making vases and ornaments. Tavernier saw Aurangzeb drink from a large cup of rock crystal

placed on a golden saucer, enriched with diamond, rubies and emeralds. What a sight! After the 1857 War of Independence, the Delhi Palace was looted and found to contain many drinking vessels, vases and pitchers made of rock crystal, which were later described by Valentine Ball.

Chalcedony is known as a compact of silica and hydrated silica, slightly lighter and softer than quartz. Its many varieties are available in India: carnelian (red), sard (brown), plasma (dark green), heliotrope or blood-stone (green, spotted with red), agate and onyx (banded structure) etc. Agate and carnelian were mined, processed and used in India even in the Pre-Harappan times. Yellowish varieties, containing hydrated ferric oxide, used to be dehydrated on heating, and thus reddened to the anhydrous ferric oxide stage and beautiful carnelian in an age-old practice. The best known deposits are found in the Rajpipla hills at Ratanpur, on the lower Narmada river. Deposits of carnelian were mined and processed also near the Mahi river, north of Baroda.

The mining and working of the stones at Ratanpur were vividly described in 1878 by J.M. Campbell (Bombay Gazetteer, Vol. VI, p. 205-) and reproduced by Valentine Ball (Ref. no. 4, pp. 507-513). A suitable extract is given below:

"The mine shafts are about 4 feet in diameter, and on an average about 30 feet deep. At the foot of each shaft, galleries 5 feet high and 4 feet wide branch off on all sides. These passages, seldom more than 100 yards long, in many cases join the galleries of other mines. At the mine mouth, the stones are chipped, and the likely ones carried to Ratanpur, the village of gems.

"The contractor divides the stones into two classes, those which should, and those which should not be baked. Three kinds are *not* baked: onyx called *mora* or *bawa ghori*, the cat's eye called *cheshamdar* or *dola*, any yellow half-clear pebble called *rorī* or *lasaniā*. The other kinds of pebbles are baked to bring out their colours. During the hot season, the stones are spread in the sun in an open field. During other seasones, the stones are gathered in earthen pots and heated in piles of ignited cowdung cakes. Then the stones are taken to Broach and Cambay.

"By exposure to sun and fire, maize yellow gains a rosy tint, orange is intensified into red; the hue of the red carnelian varies from the palest flesh to the deepest blood red..... The larger and thicker the stone, the more it is esteemed. Four kinds of agates, the common, the moss, the kapadvanj, and the veined, rank next to the Rajpipla carnelians.

"The moss agate, *suabhaji*, comes from Budkotra, 3 miles from Tankara in Morvi. Kapadvanj provides another variety of agate. The most valued Cambay agate, the veined agate, *doradar*, comes from Ranpur in Ahmedabad.

"Of other stones processed in Cambay, jasper or bloodstone, the chocolate stone, a variegated pebble known as *maimariam* and the rock crystal are found in Gujarat.

The lapis lazuli, obsidian and the blue stone *piroja* (turquoise) are foreign stones brought from Bombay. The rock crystal comes from Tankara in Morvi, the best varieties from Madras, Ceylon and China.

"The rough stone generally passes through three processes, sawing, chiselling and polishing. (These were described in detail)..... Cambay agate ornaments belong to three classes : those suited for the Chinese, Arab, and the European markets.

"The trade in Cambay stones at present (1878) supports about 600 familes of skilled workman, and from 500 to 600 unskilled labourers. Each process is carried on in a distinct workshop under a *kārkhānāwālā* or head of the factory. In each branch of the craft, the heads of factories form a distinct guild or panchayat. The *akikia*, or the agate-dealer must be a man of some capital to buy the incoming rough stones, process them and pass on the finished articles to the agate merchants of Bombay, and through them to Calcutta, China or Jedda". Ratanpur in the territory of the Raja of Rajpipla has been the centre of the 2000 years old (may be older)international trade on articles made of agate and carnelian.

Corundum, Ruby and Sapphire

Valentine Ball (Ref. no. 4, chapter 9) gave a fairly detailed account of the aluminium – containing gem minerals as found and used in pre-modern India. Corundum, when pure, is sesquioxide of aluminium: Al_3O_3, containing traces of lime, silica and magnesia. It is next to diamond in hardness, and widely known as emery (abrasive) in granular form. Typical interstitial and lattice-replacing atoms make corundum red, when it is known as 'ruby', and blue, when it is called 'sapphire'.

It is well-accpeted that the use of white corundum started in India. Even the name is derived from the Sanskrit word *kuruvinda*. The British travellers of the early 19th century reported indigenous mining works on corundum in India. Captain Newbold for example, found in the 1840's, widespread corundum mining in the Salem district: at Caranel, Anpore, Mallapollaye, and at various localities up the river Kaveri, as far as Coacorambadi, 'where it had been dug up in the fields, and the remains of the excavations were still to be traced'. Newbold also described the mines at Golhushully and Kulkairi in Mysore (Journal Royal Asiatic Society, Vol. VII, pp. 219-224). The corundum occurred in both the crystalline and amorphous conditions in more or less decomposed talcose schists. The material mined from shallow pits was separated into four classes: the red, white, scraps of both, and refuse. The first three were conveyed to Mangalore and Tellicherry and were sold to Bombay and Arab merchants for Rs. 12-30 per *kandy* (= 500 lbs.?) according to quality. These mines had been opened in 1829.

The stone known as *kurund* used to be mined during the 1850's in the upper parts of the upper Godāvārī district, specially near Bhadrāchalam.

The first mention of the occurrence of corundum at Pipra, Singrowli (latitude 23°57', longitude 82°44') in the erstwhile Rewah State was made by Francis Buchanan Hamilton (Edin. Phil. Jour. vol II, p. 305, 1820). He had been prevented from visiting the mine in 1814. Captain W.S. Sherwill's report in 1845 (Journal Asiatic Society Bengal, Vol. XIV, Proc., p. 15) indicated that the material at Pipra was of six varieties: *gulabi* rose colour, *massuria*, like massur dal, a pea or lentil, *bhaka*, of varied colours, *telia*, of the colour of the *teli* seed, mica-mixed and fibrolite-mixed. In his papers (Records Geological Survey of India, Vol. V, p. 20, 1872 and Vol. VI, p. 43, 1873), F.R. Mallet published accounts of his visit to this mine situated on a hill between Pipra and Kadopani. Several yards (at places 30 yards) thick reddish gray bed of corundum rested between quartz schist and porphyritic gneiss with hornblende rock. Traceable about half a mile, the deposit appeared to Mallet to be 'practically inexhaustible'. Considerable amount of pre-modern mining must have taken place before 1814, and this was still going on in 1871.

Holland described[15] the Indian lapidary (*begri*) using different kinds of discs (*sān*) for cutting precious stones. The corundum – sān or lapideries' wheel as used in the 19th century India, was composed of about two-thirds of finely crushed corundum cemented with one-third of lac resin. Corundum discs of differnet grades were used for the rough cutting of minerals softer than diamonds, while the polishing was done on discs of bell-metal or pewter. Besides the ordinary *begri* or lapidary, there were men whose business was to bore holes through precious stones, and they were known as *bidhiya*. W. Hoey made a comprehensive report in 1880 on the trade and manufactures of gemstones including rubies and sapphires.

Rubies were reported in the Salem district and the Mahānadī river between Cuttack and Sambalpur, but most materials came from upper Burma-places like Kyatpyen, 70 miles north-east of Mandalay. Sri Lanka provided most of the sapphires. Many of the famous rubies known in Europe can be recognised to be of Indian origin on account of the way in which they are pierced through the middle. One such huge specimen acquired in 1367 is now placed in front of the crown of the British queen[15]. Similarly, one Indian sapphire weighing 225 carats was brought to England in 1856.

One 563 carat 'Star Sapphire of India' is displayed in the American Museum of Natural History, New York. The Smithsonian Institution in Washington possesses 'Star of Bombay' corundum, 'Bismarck Sapphire' of Sri Lanka and the Roser Reeves Collection of ruby gems. Writing sometime in the middle of the seventeenth century, Nicols mentioned about ziroon gems being found in Cananor and Cambay in India[16]. The alluvium at Ellora contained large obtuse octahedron crystals of zircon along with corundum, and these (Sanskrit, *gomeda,* red ones known as hyacinth) must have been utilised by the jewellers of Cambay.

Garnet jewels were also popular in India. Voysey, Newbold and others reported recovery of garnets from the Mahanadi bed in Orissa, Kondapilli (lat. 16°38', long. 80°36') in the Godavari district, Gharibpeth, 8 miles south of Paloncha in Hyderabad

etc. There were extensive mines of garnet in the Kishengarh State of Rajputana near Sarwar (lat 26°4', long 75°4'30") from which gems of large size and good colour were obtained, and the Raja derived a large revenue.

"For a distance of about a mile, the outcrop has been burrowed into. It is believed that the large polished garnets cut *en cabuchon* which are available for sale in the principal towns of Punjab, have been obtained in these mines" (Ref. no. 4, p. 523).

The mining and widespread trade of beryl in India, ever since the days of Pāṇini, has been discussed elsewhere[14]. When the Britishers came to India, they found that the mines had been nearly exhausted. Clarke reported Mysore Beryls (Madras Journal of Lit. And Sci. Vol. IX, p. 121, 1839), and Capt. Newbold wrote on the Coimbatore deposit (Edin. Phil. Jour., 1840). The Paddoor mine in Coimbatore had been worked for two years in 1818 by one Mr. Heath; when Newbold visited, the mining had ceased. The rock there is a vein or dyke of coarse granite consisting of quartz, garnet, mica etc.; the cavities in cleavlandite felspar contained beryl crystal. Newbold also alluded to a report that beryl used to be mined at Vaniambadi, at the northern base of the Nilgiris.

Aquamarine crystals from Kangiam in Coimbatore were exhibited at the Vienna Exhibition, during the middle of the 19th century. There are current reports during the end of this 20th century, that many aquamarine crystals may be recovered from the detrital deposits on the bank of the Mahanadi in Orissa.

DIAMOND

Now let us pass on to the most outstanding gem mineral that India ever produced: diamond. C. Ritter in his *Erdkunde von Asien* (Vol. iv, part 2, p. 343, 1836) collected together the various scattered reports on Indian diamond. Valentine Ball provided a more exhaustive account of the diamond works in pre-modern India (Ref. no. 4, pp. 1-50).

C. Ritter arranged the Indian diamond mines known to him in five groups, in order from south to north:

1. The *Cuddapah* Group on the Penner river including the ancient mines of Condapetta, Munimadagu, Wajra Karur etc.

2. The *Nandial* Group between the Penner and the Krishna river including the mines of Banaganapalli, Ramulkota etc.

3. The *Ellore* or *Golconda* Group on the Krishna. This includes the famous mines of Kollur, Partial, Muleli or Malavilly.

4. The *Sambalpur* Group on the Mahanadi river. In this group Tavernier's Sumelpur

or Semah/Semul on the North Koel river as well as Wairagarh of the Central Provinces were included.

5. The *Panna* Group in Bundelkhand.

Bauer's map of the ancient diamond fields of India[17] is reproduced in Fig. 1. We would discuss diamond mining in pre-modern India from a chronological point of view and on the basis of literary and archaeological evidences.

Bauer commented[17] that the working of the most important diamond deposits in India known at present 'date back not to very remote periods, probably in all cases subsequent to the year 1000 A.D. and sometimes much later'. Though we do not have specific C-14 dates, we disagree with Bauer on the basis of literary records. The currently known diamond fields on India are shown in Fig. 1.

Kauṭilya's *Arthaśāstra* of the late fourth century B.C. was probably the first text to describe the Indian diamond or *vajra* and the mode and area of its occurrence (2.11.37-41). The mine and stream deposits were listed as their sources.

It is hard to idenitfy the precise locations of the place names mentioned in *Arthaśāstra, Bṛhatsaṃhitā, Ratnaparīkṣā, Agastimata* etc. regarding the diamond fields, but we may conjecture the following locations: Wairagadh (ancient Vajragṛha) eight miles south-east of Nagpur on the Sath river, a tributary of Weinganga (Vena Gaṅgā of the *Bṛhatsaṃhita*); the Kośala region of Ākarāvanti around the famous Panna in Madhya Pradesh; the region around the Golconda mines, formerly known as Mātaṅga; the Paunda or the Chota Nagpur area around Soumelpur; the Kaliṅga alluvial resources from the Mahanadi valley, the Sambalpur district, the Koel river, Hīrākund (literally 'diamond mine') etc. Diamond – washing has been traditionally done by the tribes of *Śavara* (Sambalpur area) *Kol* (Chota Nagpur), Gond (Madhya Pradesh) etc. Ptolemy had mentioned the country of the Śavaras and Sambalaka (Soumelpur) and of the Mandalai (Mundas) as the sources of Manada (Mahanadi).

Ancient Diamond Works in the Godavari-Krishna-Penner Valleys

We have earlier mentioned the accounts of the Muslim and European travellers related to Indian diamonds upto the period of the middle of the seventeenth century. During the second half of the 17th century, some accounts of Indian diamond mines were published by Tavernier (1676) and Henry Howard (who later attained the honorific title, Earl Marshal), the latter in the *Philosophical Transactions*, Vol. xii, 1677, p. 907 as quoted by Ball (Ref. no. 5, p. 352.). Howard enumerated[18] 23 mines in the kingdom of Golconda and 15 in the kingdom of Bijapur. Some of the imprtant Golconda mines reported were Kollur (somewhat exhausted by 1677), Vajra Karur earlier annexed from the Vijayanagara kings, Munimadagu in Karnaul (40 to 50 fathom deep mining), Malavalle etc. In Bijapur area, there were mines of Rammalakota, Banaganapalle (37 mile SE of Karnaul). Howard, later Earl Marshal, mentioned in his paper that in

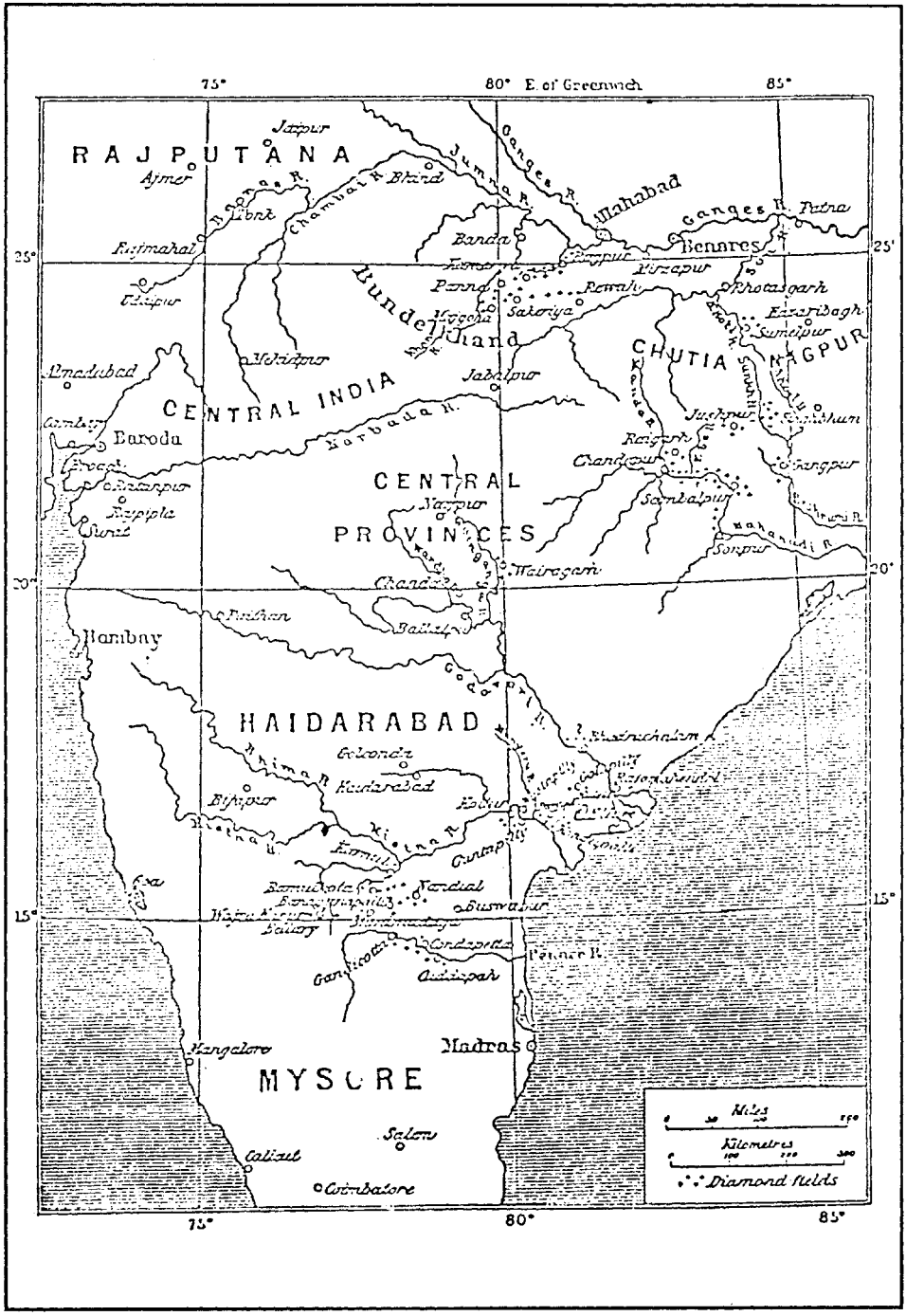

Fig. 1. The Diamond-Fields of India (Taken from Bauer[17])

Golkonda the miners and merchants were much oppressed, and in a miserable state of poverty; they suffered from tyrannical squeezing and heavy duties on provisions.

During the commencement of the seventeenth century (around 1610 A.D.), a Portuguese trader had good luck in obtaining a 435 carat diamond around Wajra Karur in the Bellary district (Mir Jumla later took possession of this mine in 1640 from the local kings), and celebrated the occasion by engraving a Telugu poem on a stone tablet praising the lucky Currure.

William Methold reported the discovery (by chance finding) of the Kollur mine on the Krishna river sometimes during 1622-1626. Some 30,000 to 60,000 persons (township population 1 lakh) were engaged in bailing out the mines by hand, a tedious operation. The wage earned was ridiculously small, one rupee per month, forcing the workers to steal the gems occasionally. The king had farmed out the area to the prospector-merchants, reserving the samples above 10 carats for himself. In 1622, the Moghul emperor demanded a tribute of 3 lbs. weight of the finest diamonds when the operation was temporarily closed.

Tavernier described the diamond-processing operations at Kollur (lat. 16°42'30", long 80°5') and Rammalakota (lat. 15°34, long 78°3'15"). In the former site, the processing of the alluvial bed started after ceremonial prayers. The men excavated the earth – 10 to 14 ft in depth – till the water – table was reached. The earth was washed in 2 ft high enclosures with exit openings for water and the slimes. The women and children assisted in washing the clay. The residual coarse material was dried in sun and then winnowed to remove the fine components. The coarse material, thus obtained, was pounded by wooden pestle to liberate hard diamond if any, which were looked for. Tavernier commented: "Formerly, instead of using wooden pestles for pounding the earth, they pounded it with stones which regrettably produced so many flaws in the diamonds". The Kollur mine became exhausted by 1673.

The technique adopted at Rammalakota (and also later in the neighbouring Banaganapilly) was entirely different. The diamond veins in the conglomerate rocks were mined with small irons, crooked at the ends, 'which were thrust into the veins to draw from them the sand or earth and then placed in the vessels for washing'. The directions of the veins were followed to obtain the cleanest and the whitest diamonds. The heavy iron crowbar often fractured the diamonds, giving rise to flaws. 'This is the reason why so many thin stones (*foible*) came from this mine'.

Tavernier also described diamond – cutting on the site by steel-wheel, aided by water, oil and diamond dust. He observed: "The Indians are unable to give the stones such a lively polish as we give them in Europe; this, I believe, is due to the fact that their wheels do not run so smoothly as ours".

There was brisk business around the mines 'conducted with freedom and fidelity'. Two percent on all purchases was paid to the king. Even children of age ten to sixteen

were proficient diamond-testers handling big and defective specimens and cabuchons (diamond polished but not cut) with equal ease (Ref. no. 5, pp. 43-51). Visitors like Tavernier were courteously treated.

Some 150 years later, Benjamin Heyne visited the neighbouring Banaganapilly mines in 1808. His writing (*Tracts*) was quoted by King[19].

"The quartzites of the Banaganapilly group from a cap resting on a much older set of shales and traps with some limestone bands _____. The quartzite covering is from 20 to 30 feet in thickness, and it is pierced here and there by shafts of 15 feet or less, from the bottoms of which nearly horizontal galleries are run to get at the seams of diamond gangue ..... . In the mines, 6 to 8 inches thick diamond layers were scooped out, and the clayey conglomerate easily broken up. The mass was pounded up, washed, sifted and laid out to dry on prepared floors. The residue of clean sand was carefully examined by the women and children of the working parties, for the precious gems".

The ancient diamond mines in the Bhima – Tungabhadra – Krishna – Godavari valleys in the Andhra Pradesh region (vide Fig. 1.) have been specially studied and reported by Voysey[20] (1833), King[19] (1872), Munn[21] (1929), Dutt[22] (1953) and Rao[23] (1969). Dutt has drawn attention[22] to the occurrence of diamond mines in the Andhra Pradesh region in three forms: (1) in river gravels (2) sedimentary rocks or detritals and (3) in the Archaean crystallites. Except in river alluvials, no occurrence of diamond has been reported from the eastern portion of the sedimentary area. On this basis, Dutt has postulated[22] that the west of the Cuddapah – Kurnool rocks or the Archaean crystallites, which produced largest diamonds, was the probable geological home of the regional diamond, and from this area the gem was transported by the rivers winding easterly. Rao has reported[23] a large number of ancient diamond mines in a narrow area of the Krishna valley (between latitude 16°02' to 16°39' and longitude 78°19' to 80°25'), those of Kolhapur, Bollaram, Amargiri, Somsil, Maddimadugu, Thigamanpenta, Partial etc.

Some of the ancient works were reported by Howard[18]. A common feature of many of these works was the use of stone cisterns, which were washing places (as described by Tavernier in connection with the Kollur mines). The material excavated from the pits used to be soaked in water in these cisterns and washed several times by letting out the water through the holes at the bottom of the walls. The residue was then examined for diamonds after drying, and in some places, after gently powdering and winnowing the same.

The alluvial workings around the Penner river in the Cuddapah district are also worth mentioning. Ball referred to the old workings of Kanuparti (14°34', 78°49') – the Condapetta of Dr. Heyne and Captain Newbold – and Obalampalie (14°33'; 78°51'35) – Dorlampalle on the map. These two sites are near Chennur, but on the opposite banks of the Penner river. Captain Newbold wrote (Ref. no. 4, pp. 9 -11):

"At Condapetta the mines are generally of a square form, and 4 to 12 feet deep. The stratum cut through is of cotton soil, mixed with small grains of quartz, generally from 3 to 10 feet thick, which rests immediately on a bed of rolled stones of various sizes, in which the diamonds are found generally loose, but sometimes adherent ..... . The process of mining consists merely in digging out the rolled pebbles and gravel, and carrying them to small square reservoirs raised on mounds having their bottoms paved with stones, and washing them carefully ..... . The diamonds are easily recognized in the moist state by their peculiar lustre".

Newbold's description referred to the workings which were administered by the East India Company but followed the ancient methods.

"In former days all the diamonds produced were carried for sale to Golconda. In those times very large diamonds were found, but subsequent to the British ascendancy – which according to the superstitious natives, is by no means pleasing to the tutelary deities of the mines – few of any value have been found, probably in consequance of their being less looked after. However, lately, in 1839, a fine diamond of the *Kṣatriya* or roseate caste was dug from the Obalampalle mine (discovered around 1755 A.D. according to Dr. Heyne), exceeding a gold pagoda (16 carats) in weight, which was sold for Rs. 1450".

Both Dr. Heyne and Captain Newbold mentioned while describing their visits to these mines that 'the local miners objected to their approaching them on horseback, as it would, they said, irritate Ammawaru or Lakshmi, the sanguinary goddess of riches, who was the patroness of the mines'. Newbold witnessed sacrifices to propitiate her and noted the Telugu terms for different kinds of stones which the miners referred to as associates of diamond: *binga bendu*, transparent quartz; *patcha bendu*, epidote; *baggira*, jasper; *karla*, basalt; *Yerra bendu*, sandotone; *korund* or corundum, which was considered to be the best sign, indicating possible association with diamond. A Brahmin class diamond fetched a price almost the double of Śudra class of equal weight.

The valleys of Tungabhadra, Bhima, Krishna, Godavari and Penner had provided enough Archaean crystallite diamonds (vide Fig. 1.) to the South Indians for centuries. This has been reflected in many writings, starting from Amir Khusrau's description of the sack of Warangal and the loot of diamonds (early 14th century) and ending up to Heyne and Newbbold's narrative of the superstitious but crafty Telugu-speaking miners on the Penner river (19th century) . Ball noted (Ref. no. 5, pp.349-351) ancient diamond mines in 52 specific localities in this region (lalitudes 14 to 17° and longitudes 77 to 80°).

The Ancient Diamond Mines of Bengal – Bihar – Orissa

In his writings on the 'Diamond mines of (greater) Bengal', Valentine Ball (Ref. no. 4, pp.24-37; Ref. no. 5, pp.354-359, Appendix III) drew attention to the three

distinct localities in the Bengal – Bihar – Orissa region which produced diamond in the pre-modern period:

(1) the Sema on the Koel flowing northwards, a tributary of the Son

(2) the Sankh river flowing southwards on the other side of the watershed, one of the tributaries of the Brahmani, and

(3) Sambalpur – Hirakund area on the Mahanadi further south (vide Fig. 1.).

About 81 miles south of Rohtasgarh on the bank of the Koel, we have the remains of an old town Semah (lat, 23°35', long. 84°21') which was Tavernier's Soumelpour, a corruption of Śimulpur (the *Śimul* is the silk cotton tree, *Bombax malabaricum*). On the other side of the watershed from which Koel originates to flow northwards, the Sankh river flows southwards to join Bahmani. Since both the rivers produced alluvial deposits containing diamond, the origin of the gem mineral must have been the common watershed or the bedrock of the hills (vide Fig. 1.).

This area was probably known to Ptolemy as Sambalaka of Mandalai (Mundās, who also produced Mundaloha or iron around Lohardugga) and later to the Moguls as Kokrah, an abbreviation of Kokko-nage or Chota Nagpur.

Blochmann reported (Journal of Asiatic Society of Bengal, Vol. XL, p. 113) two notices of Kokrah – one in *Akbarnamah* and the other in *Tuzuk-i-Jahangiri*. In 1585, Madhu Singh, ruler of Kokrah, accepted subservience to Akbar. In 1616, Ibrahim Khan, Jahangir's governor at Bihar, overran Kokrah and took possession of its diamond resources. *Jahangiri* records:

"This district belongs to *Subah* Bihar, and the river which flows through it yields the diamonds. When the river contains little water, tumuli and hollows are formed. The diamond-diggers know from experience that those tumuli chiefly, contain diamonds over which insects, called by the Hindus *Jhinga*, hover. They pile up stones on all sides of the tumuli, and then cut into them with hatchets and chisels and collect the diamonds from among the sand and stones. Sometimes diamonds are found of the value of a lakh of rupees each. When I (Jahangir) appointed Ibrahim Khan governor of Bihar, I told him to invade the district and deprive the zemindar Durjan Sal of all the diamonds in his possession.

"The district is now subject to me. All diamonds found in the river are forwarded to courts. Only a few days ago, a diamond arrived which had a value of Rs. 50000. There is one which looks like sapphire; I have never seen a diamond of such a colour. My lapidaries fix its value at Rs. 3000, though they would give Rs. 20000 for it if it were quite white and stood the full test" (Quoted by Ball Ref. no. 4, pp. 25-26).

Blochmann believed that the diamond-river alluded to was the Sunk. To the

present day a spot in the Sunk is pointed out by the inhabitants as being a place where diamonds were washed. The present author feels that Jahangir's diamond-river could be as well (north) Koel, corresponding to Tavernier's Soumelpour or modern Semah. Tavernier wrote:

"Soumelpour is a great town, the houses whereof are built of earth and covered only with branches of cocoanut trees. The Raja lives half a *coste* (little over a mile) from the town in tents, set upon a fair rising gound at the foot whereof runs the Koel.

"This is the manner in which they search for diamonds. After the great rains are over (they wait till the end of January) there pour forth 8000 persons – men, women and children – those who are able to work. They, that are skilful, know by the sand whether there be any diamonds or not.

"Where they believed there are diamonds, they encompass the place with stakes, faggots, and earth; they go about to make the arch of a bridge to drain all the water out of that place. They dig out all the sand for 2 feet deep, and spread upon the side of the river in an enclosure of about 1½' ft. high. Then they wash it, and sift it, doing other things as they do at the mines".

The Rajas of this place had rebelled against the Moghuls from time to time. Ball refers (Ref. no. 4, p. 29) to a large picture by a contemporary artist, representing the attack on the fort of Palamow in 1660 by Daud Khan and depicting a figure of the *Zaminder-i-kan-i-almas*, or lord of the diamond mine, who is considered to have been a Kol Nagbansi Raja.

Sambalpur District Diamonds

Tavernier's Soumelpour or Semah is not to be confused with Sambalpur in Orissa on the Mahanadi. Ptolemy's Adamas or diamond river in the land of the Śavaras is most probably the Mahanadi. The tributaries such as the Mand and then the Ebe or Ib join the Mahanadi flowing from the west to the east (vide Fig. 2.). Diamonds have been found not on the Ebe river but on the Mahanadi river bed, west upto Chandapur. Ball conjectued (Ref. no. 4, pp. 34-35) that the quartzites, limestones, the sandstones, and the shale of the Barapahar hills provide the laterite or red earth matrix in which diamonds are found. Along with diamond, many other naturally occurring precious stones are washed down the Mahanadi river tract[24]. Ball recorded that in addition to diamonds, pebbles of beryl, topaz, carbuncle, amethyst, carnelian, and clear quartz used to be collected in the Mahanadi – this is still being done as reported by Ghosh[24] – but it is probable that the matrix of most of these exists in the metamorphic rocks on which Hirakund is located, and is, therefore, distinct from that of the diamonds (Ref. no. 4, p. 36).

The first visit to the Sambalpur diamond working ever to be reported was undertaken by Mr. Motte in 1766 at the behest of Lord Clive (Ball quoted Asiatic

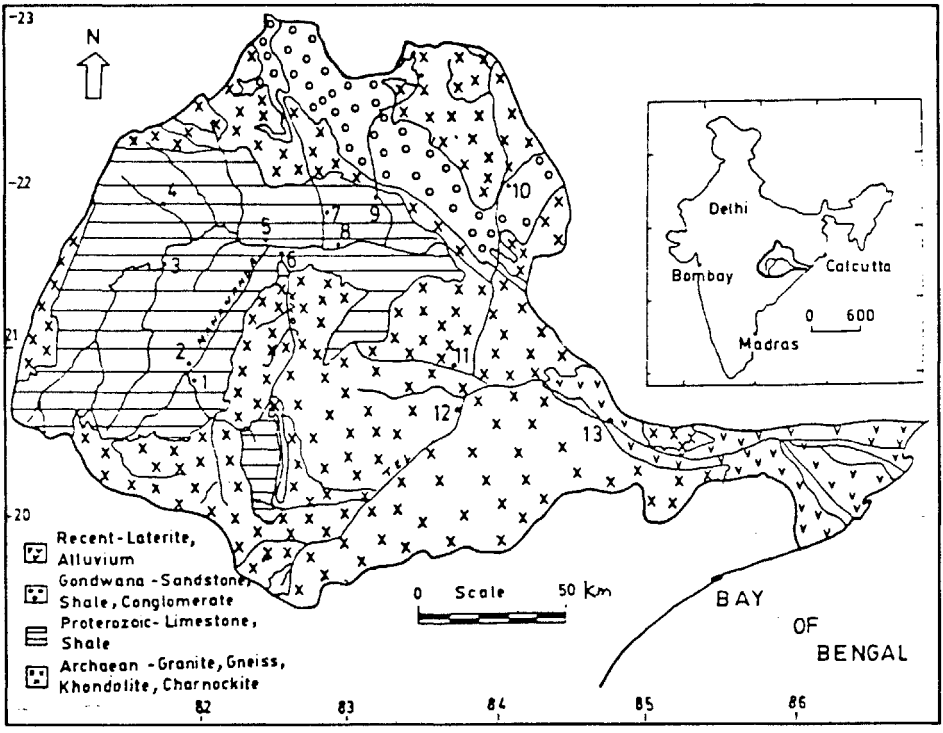

Fig. 2. Geological Map of the Mahanadi Basin (Taken From Panigrahy[25])

Locations: 1. Baronda on Pairi (Stream) 2. Rajim on Mahanadi 3. Simga on Seonath 4. Andhiyarkore 5. Jondhra 6. Rampur 7. Bamnidih 8. Basantpur on Mahanadi 9. Kurubhata on Mand 10. Sundergarh on Ib 11. Salebhata 12. Kantamal 13. Tikarpara on Mahanadi

Annual Register, London 1799 and Hamilton's *Hindustan*, Vol. II, p. 20). A servant of the Raja at Sambalpur showed Mr. Motte how diamond was being recovered from the red earth (apparently by washing). The digging operation in the mountains had been suspended on account of the Maratha raids.

Dr. Voysey (1823) and P. Breton (1825) visited the same topography going further west upto the confluence of Mand and the sites of Raigarh, Jashpur etc. Breton reported that in 1809 a large (over 200 carats) *vaiśya* quality diamond was recovered at Hirakund, but this was confiscated by the raiding Marathas. In 1836, Karl Ritter published his careful compilation on Indian diamond and other gems (Erdkunde Asien, Vol. VI, p. 343).

In 1840, Major J.R. Ouseley published his note on the process of washing for the gold dust and diamonds at Hirakund, which literally means diamond-mine (The Journal of the Asiatic Society, Vol VIII, Jan. – Dec. 1839, published in 1840, pp. 1057-58). Hirakund is located about seven miles from the eastern end of Sambalpur and four miles downstream from the confluence of the Ebe and the Mahanadi. Gold and

diamond are available on the Mahanadi down upto Sonpur.

Ball elaborated Ouseley's description with more details which he collected from the oldest of the *Jhiras*, or washers at the village of Jhunan, near Hirakund, who described to him the operations during the Raja's time, that is, before 1850 when the British took over Sambalpur. Now we quote Ball (Ref. no. 4, pp. 35-36) and Ouseley.

"In the centre of the Mahanadi, the island of Hirakund is about 4 miles long, and for that distance separates the waters of the river into two channels. In each year, about the beginning of March, when the level of water was approaching the lowest nearly five thousand people assembled and raised an embankment across the mouth of the northern channel, its share of water thus being deflected into the southern. In the stagnant pools left in the former, sufficient water remained to enable the washers to wash the gravel, accumulated between the rocks".

"The men and the children brought the gravel and sand in wooden trays and placed it in the trough, which is open at one end, with a gentle inclination towards the river. The women sat on the edge of the river. With their left hands they stir up the gravel, and with the right, pour water out of a wooden basket-looking bucket gently over the upper end; it runs out in the river, the larger pebbles and gravel are thrown over. The finer sand, on the trough being full, is rewashed, removed into wooden trays, and by dipping them under water, and shaking them about, the gravels gradually fell over, leaving only gold dust".

"They detect the diamonds (in the finer gravels) at a glance, as they wash. Once I (Ouseley) saw about the size of a large grain of wheat, clear and bright, but these are the Raja's property. The gold they are allowed to dispose of at 12 to 15 rupees per tola".

Ouseley 'fancied' that recovery of gold and diamond could be done on 'mechanical principles which would, by reducing the manual labour, make the speculation highly profitable'. He recommended a vibrating graduated wire-sieve (6' ft long. 2'ft wide) washing machine, larger at the top, and smaller as the sieves approached the bottom, below which a wooden tray could be kept. "If the machine were placed in a gentle stream, the gold dust would be found in the tray". The diamond samples could be looked for in the finer gravel fraction. Ball suggested that the southern channel of the Mahanadi, which was never emptied in the Raja's time, could yield a larger number of diamonds than the northern.

"The stronger current in it would be more efficient in removing the substances of less specific gravity than diamonds, while the rocks and deep holes in it afford admirable means for the retention of the latter. It would be more difficult to divert the body of water greater than that which flows in the northern channel; but the result in a greater harvest of diamonds would probably far more than compensate for the greater expenditure incurred" (Ref. no.4, p.35).

These suggestions were never tried in the 19th century, but in the context of the Hirakund dam and other modern developments, we may try them as we approach the 21st century.

As a matter of fact, the banks of the Mahanadi in Southern Orissa has been found to be a virtual treasure trove of precious and semi-precious stones-not only diamond but also many other gems[24]. Panigrahy has reported[25] that the physical erosion rate in the Mahanadi basin (vide Fig. 2.) varies between 146 to 707 tons/Sq. Km/Year, the uppermost value corresponding to the upland tributary Pairi ending up in Mahanadi. The ratio of physical to chemical erosion is very high varying between 5.2 to 43.0. The huge mass of solid eroded from the archaean granite and sandstone/limestone shale deserves to be monitored and beneficiated for a total recovery of the precious stones.

The diamonds washed down from the Madhya Pradesh Kimberlite rocks are still found in crevices in the rocks at Boudh. Early 1992, a 57 carat blue diamond has been found in the Mahanadi, reminding one of Jahangir's comment on a Sankh river diamond 'which looked like sapphire'. The recent findings of: aquamarine in Badmal and Sangamora in Bolangir; rubies and iolite in Jilingdhar and Hinjlibahal in Kalahandi; chrysoberyl in Koraput; sapphire in Amhera; garnet, rare voilet rhodolite at Siali and many others have made the Orissa Government arrange for high resolution aero-magnetic survey on ground water as well as mother lodes for gems in this area and seek assistance from the United Nations Development Programme in setting up semi-mechanized panning and screening facilites and mobile washing plants on the banks of Mahanadi[24]. This would fulfil the dreams of Major Ouseley and Valentine Ball!

Diamond in Central India

The ancient mine at Wairagarh (lat. 20°26', long, 80°10') situated about 80 miles to the south-east of Nagpur is of considerable antiquity. The diamonds have been found in the yellowish earth lateritic grit with quartzose and metamorphic rocks in the vicinity[26]. *Kauṭilīya's Arthaśāstra's* (2.11.37) *Sabhārāṣṭra* and Varāhamihira's *Bṛhatsaṃhitā* (80.6) *Veṇātaṭe* probably refer to diamond mines in this area. Veṇā is modern Weingangā or Vāṇagangā. Wairagarh mine is on the Sath river which ultimately joins Weinganga. Ajay Mitra Shastri has quoted[27] several Khāravela and Cola inscriptions to suggest that Wairagarh was known in the ancient times as Vajrākara or Vajragṛha, the mine or abode of diamond.

Most probably the mine, taken prossession of by Ahmed Shah Walli Bahamani in 1425 (as recorded by Ferishta), was this mine at Wairgarh. *Ain-i-Akbari* mentions this place as Beiragarh (Gladwin's translation, volume II).

R. Jenkins reported in 1827 that this mine was not yielding sufficient returns. During Raghoji Bhonsla's time the mines in the neighbourhood were worked at

considerable expense, but since only a few diamonds were found, they were finally given up. Ball suggested that the great basin of Lower Vindhyan or Karnul rocks, which occupies the upper portion of the Mahanadi valley in Madhya Pradesh, stretches into the neighbourhood of Wairgarh (vide Fig. 1.) and thus the diamond beds of the two regions have common geological genesis.

THE PANNA MINES

The mines of Bundelkhand are generally known as the Panna mines, but it is necessary to distinguish the mines near the town of Panna from those which are situated in other parts of the province. Ball mentioned (Ref. no. 4, pp. 39-49) several amongst a large number of ancient mines: Kamariya, Panna (or Punnah), Majgoha, Brijpur, Udesna, Sakeriya, Baghin, Myra, Etwa, Bargari, Saya Luchmanpur etc. – of which the first three were more important than the others.

In this area, the origin of diamond is in volcanic pipes. Ultra-basic diamondiferrous plug is made up of a highly serpentised rock akin to the kimberlite of South Africa. The plug consists of greenish clay for the first few feet of depth. Deeper it becomes harder and is found to be greenish 'tuff' (volcanic rock). Crystals of quartz, calcite and olivine are bedded in a serpentinised groundmass[28]. The green mud is actually quartz containing hydrated nickel silicate, known as chrysoprase, prase, plasma and also 'mother of emerald'.

KAMARIYA mine was visited and described by Capt. Franklin (1827) and H.B. Medlicott (1860). The diamond stratum, locally called *kakru*, consists of a conglomerate sandstone made up of pebbles, 1/8 to 1/2" in diameter, embedded in a rather fine matrix. Thee were numerous old pits in this area and around Bungla and Babupur, 10-20' ft. deep. There was an old pit south-west of Kamariya which was 30-40' ft. deep and abandoned, because the bottom was filled with water. Franklin considered the green pebbles to be an indicator of the presence of diamond in the bed.

PANNA: The mines, situated about 2-3 miles to the north-east of Panna (lat. 24°43'30", long. 80°15') were frequently visited and reported during the 19th century: Dr. F. Hamilton (1813), Capt. Pogson writing *The History of Boondelas* (1826), Capt. Franklin (1827), J. Adam (1840), H.B. Medlicott (1860), M. Rousselet (1874), W.L. Wilson (1877), – all quoted by Valentine Ball in 1881. Ball described:

"In the Panna mines, although the diamond seam is deeper than elsewhere, it is not reached by a shaft, but the miners go to the immense labour of excavating great pits, 25 ft. in diameter, and often over 30 feet deep, for the sake of the small patch of diamond conglomerate.

"The almost naked miners enter the pit by an inclined plane and work knee – deep in water. The stones and mud which they excavate are put into small baskets which are drawn up by hand. The Persian wheel turned by four bullocks is insufficient

in power to thoroughly drain the place; water was lifted by a band of earthen vessles". (Ref. no. 4, p. 40)

The above – described system of mining in practice at Panna was illustrated through a sketch drawn by Jules Schaumburg, who accompanied M. Rousselet to Panna in the year 1867. The illustration was published in Rousselet's *L'Inde des Rajahs* (1874, pp. 441-443) and reproduced by V. Ball (Ref. no. 4, facing p. 40). Ball continued:

"The stuff on reaching the surface is placed on stone slabs and is searched, the searchers being under the charge of guards, as are also the miners".

MAJGOHA, now known as Majhgawan, is the westernmost point in the diamond area and was visited by Franklin and Medlicott. The former described the mine to be a huge basin, like an inverted cone, 100 yards wide and about 100 feet deep. The diamonds occurred with the green mud, more below a depth of 50 feet. The 19th century applicances did not permit large scale mining.

A survey around 1960 suggested that the total reserves of diamondiferous 'tuff' material at Majhgawan would be about 56 million tons with a diamond content of about 3 million carats; this could be recovered by a combination of diverse and modern mineral beneficiation techniques. As a matter of fact centralised diamond dressing plants were recommended to treat diverse diamond – bearing ores in the country.[28]

The recent explorations thoroughly justify the observation made by Franklin one and a half century ago that 'an improved system of mining (at Majgoha) might be applied with good effect'. We are indebted to him and the other 19th century British geologists and travellers for meticulously noting the ancient diamond – mining practices in India.

Valentine Ball quoted an anonymous report on Panna diamonds published in an Indian newspaper and provided further details. Whereas in the time of Akbar the value of the diamond mines was about 8 lakhs of rupees a year, in 1750 the profit came down to 4 lakhs, and Franklin reported in 1827 the annual produce to be worth 1.2 lakhs of rupees only. A very insignificant amount was paid in wages to the miners. The monthly expenditure incurred in one mine was Rs. 122 only, 20 bilders and 15 waterwomen getting Rs. 2 per person per month, 4 sepoys each at Rs. 3 and the rest (Rs. 40) spent as digging cost.

The poor miners working at the *ghaira* (deep mines) and *chila* (surface pits) were inhumanly supervised by *tuadars* (masters of the mines) who in turn were mercilessly exploited by the Raja through oppressive rules. To counter this chain of oppression, the *tuadars* would often smuggle valuable gems to the loan-giving bankers or *mahājans* who would carry on clandestine trade of diamonds between Mirzapur, Varanasi,

Allahabad and Jabalpur. The miners would try their best to pilfer and conceal the best gems, and even 'in case of emergency, swallow them'!

THE DECLINE IN THE DIAMOND TRADE

Valentine Ball asserted (Ref. no. 4, p. 48) that there was no real exhaustion of the localities where diamond mining was possible. On the contrary, the diamond beds were extended far more than the ancient miners ever supposed. They acted on chance discoveries and rule of thumb knowledge. That they systematised their observation about the diamond – bearing strata and applied them to distant tracts is extremely doubtful. There is no evidence that any intercourse or communication took place between the workers at distant localities. Ball hoped that scientific guidance would improve diamond production in India.

Dutt attributed[22] various reasons to the decline of Indian diamond industry: exhaustion of the diamond – bearing rocks, water trouble in the excavations, oppressive nature of the mining and political administration, absence of systematic prospecting operations, superstitions amongst the workers and the discovery of diamond fields in other parts of the world. India lost its monopoly in diamond trade in 1728 when the Brazilian mines were first exploited. In 1870 the South African mines monopolized the global markets in this precious gem.

CONCLUDING REMARKS

The pre-modern Indian traditions in gem production were doomed to extinction in view of the inefficient technology and management which also hovered over the non-gem mineral and metallurgical industries as well. Thus the comments made by Ball (Ref. no. 4 p. 48) and Dutt[22] on ancient diamond mining in India have general applicability. The common issues may be discussed later in a broader framework.

Our present discussion on gem mineral in pre-modern India indicates a remarkable continuity in traditions from the sixth to the end of the eighteenth century. This has been adequately testified by the Arab, Persian and the European travellers. The British travellers and scientists of the 18th and 19th century witnessed pre-modern technologies on mining and processing of gem minerals and left detailed accounts which have been brilliantly summed up by Valentine Ball[4].

The Sanskrit words for gem minerals, culled from the *Ratnaśāstra* and the *Rasaśāstra* texts, were compiled and tabulated by the present author[1]. Some of the Arabic/Persian words used in medieval India and their approximate or likely English equivalents[15,29,30] are provided in Table 1.

Mining and processing of gem minerals used to be done for the affluent part of the Indian society and the outside world. For low quantum of output, a very large number of poor people worked under appalling conditions. Technological levels were

primitive and almost no attempt was made to upgrade them. Interactions between workers of different trade guilds, and between workers and intellectuals were negligible. The scholars of the *Ratnaśāstras* and the Muslim gemmological texts hardly advanced their earlier knowledge on the subject. In such an apathetic atmosphere, the ill-paid and ill-fed Indian workers toiled in the mines and produced exquisite art-jewelleries for the whole world to marvel at.

TABLE 1

SOME PERSIAN/ARABIC/HINDUSTANI TERMS REGARDING GEM MINERALS USED IN PRE-MODERN INDIA

(Taken from Holland[15], Prinsep[29] and Tagore[30])

ABU-IS'HAQI-	Father of Isaac or 'genuine' turquoise, product of Nishapur in Khorasan, discoloured by heating. Probably this is *calaite* variety of turquoise containing 18 p.c. water.
AKĪK-	agate (also carnelian in Yemen)
AKĪKIYA-	gem cutter and polisher
A'LMĀSH-	also ALMĀS – diamond. See MĀSH
ĀYN-UL-HIREH-	cat's eye, chatoyant sapphire
BADAKSHĀNI-	Turquoise differnt from Abu-Is'haqi or Nishapuri variety. Withstands heat or fire without alteration. Could be odontolite or bone turquoise. Badakshani ruby is Balas-ruby.
BASUD-	Coral-like porous material devoid of gelatinous mass, available in Yemen, Maldive sea-water.
BAWA GHORI-	onyx
BEGRI-	lapidary
BELLĀOR/BELLOR/BILHAUR-	see BILOR
BERŪJ-	beryl from *vaidūrya* (Sanskrit)
BIDHIYĀ-	who bores holes through precious stones
BILOR-	rock crystal
CHESHAMDAR-	quartz cat's eye, also DOLA
CHUṆI-	ruby weighing less than one rati
DOLA-	quartz cat's eye
DSCHEMST-	amethyst
EBRENDSHE-	gold marcasite
FEROZĀ/FIROZEH/FIRUSE/PĒROJ-	turquoise See Abu – is'haqi and Badakshani
GULĀBĪ-	rose – coloured corundum from Rewah
HALIK-	agate. See AKĪK

HUKKĀK-	cutters and polishers of gem.
HUZUR-	gem (Arabic)
ILMAS-	actually A'LMĀSH or diamond
JASCHEP-	jasper
JAUHAR/JAWĀHIR/JAWAHAR-	jewel
JUZĀ-	Cat's eye found in the mines of AKĪK or agate
KAMĀNĪ-	a bow used for working a gimlet in gem-stone boring (Hindustani)
KASH-	from *Yu she*, Chinese for jade which comes from Eastern Turkistan. Hence the name of the place is Kashgarh.
KORUND/KŪRŪN-	corundum from kuruvinda (Sanskrit)
LĀJBURUD/LĀJAWARD-	blue lapis lazuli. In Sanskrit *rājāvarta*
LĀL-	red-coloured balas or spinel ruby
LĀL-BADAKSHANI-	rose coloured ruby of Badakshan, capital Balkh. Bala-ruby, *Bālasūryaka* in Arthaśāstra
LĀL-MINA-	violet coloured almandine ruby
LĀL-PIAZI-	onion coloured, reddish yellow ruby
LĀL-PUN NĪLA-	sapphire with a tinge of red
LĀL – RUMANI-	scarlet or pomegranate coloured ruby, usually from Burma.
LULU-	pearl (Arabic)
MANAK/MĀNIK-	ruby weighing over one rati. See CHUNI
MARK-I-SHĪSĀ-	marcasite or iron pyrite
MAROWARIT/MERWARID-	margarita or pearl
MĀSH-	diamond (Arabic)
MORA-	onyx
MURJĀN-	coral, best variety MUGĀ
NĪLĀ-	sapphire (blue)
PITONIĀ-	heliotrope or bloodstone which is green gem (plasma) interspersed with dots of red
POKHRĀJ/PUKHRĀJ-	topaz
RAG-Ī-LĀL-	vein of rubies
SANE-	corundum wheel or stone-cutting wheel, also for polishing gems and sharpening tools
SANGTARĀSH-	stone-cutter
SARD-	sardonyx
SENBADE-	corundum
SITAREI SEMIN-	star of the earth or talc

SONELĀ-	an inferior variety of topaz (golden)
SUABHAJI-	moss agate
SUBJ-PUN NĪLA-	sapphire with a tinge of green
SUNG-	gemstone (Persian)
TĀBLĀ-	cut rubies (Burmese)
TANJĪN-	polished rubies (Burmese)
TORĀ-	yellowish beryl
TURMALI-	'a kind of Yakut', possibly tourmaline, could also represent zircon, hyacinth etc.
UPUL-	opal (many coloured)
YĀKŪT/YĀQŪT-	hard gem minerals like ruby, sapphire etc. a generic name.
YĀKŪT-AHMAR-	oriental ruby *arghwānī* – hyacinth; *khamrī*-red-wine coloured, amethyst; *Khyli* - asafoetida-coloured; *lahmī*-flesh coloured; *mihrmātī* – striped; *rūī* - brass coloured
YĀKŪT-ARZAQ OR QABŪD-	sapphire, *nīlā; taüsī* – peacock – tail; *nīlī* – indigo
YĀKŪT-ASFAR or ZARD-	topaz, pokhraj, *narinjī*-orange; *turanjī*-citron coloured
YĀKŪT-RUMĀNĪ-	bright red ruby
YĀKŪT-SURKH-	amethyst or topaz (Gladwin)
ZABARJAD/ZUBURZUD-	beryl, green aquamarine; also confused with yellow chryso-beryl and topaz
ZAFFRE-	cobalt sulphide used for painting of glass and porcelain
ZAHĀBĪ-	gold coloured or yellow beryl
ZAMARŪD/ZUMĀRRŪD-	emerald, green crystalline.

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