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Topographic Changes in Central Aravalli Region Due to Quarrying Activity

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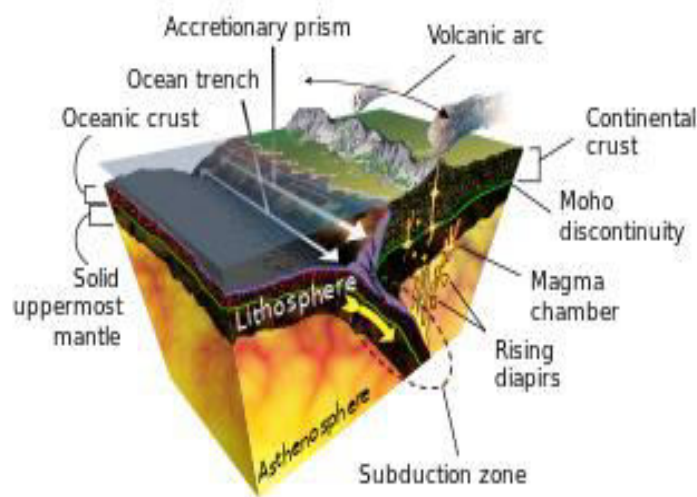
ABSTRACT: The Aravalli Range (also spelled Aravali) is a mountain range in Northern-Western India, running approximately 670 km (420 mi) in a south-west direction, starting near Delhi, passing through southern Haryana,^[1] Rajasthan, and ending in Ahmedabad Gujarat.^{[2][3]} The highest peak is Guru Shikhar on Mount Abu at 1,722 m (5,650 ft). The Aravalli Range is arguably the oldest geological feature on Earth,^{[4][5][6][7]} having its origin in the Proterozoic era.

The Aravalli Range is rich in natural resources and serves as check to the growth of the western desert.

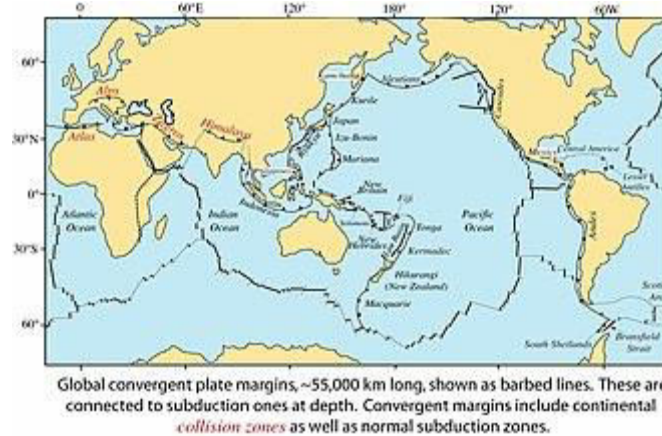
KEYWORDS-topographic, central, Aravalli, quarrying, changes

I.INTRODUCTION

The Aravalli Range, an eroded stub of ancient mountains, is believed to be the oldest range of fold mountains in India.^[10] The natural history of the Aravalli Range dates back to times when the Indian Plate was separated from the Eurasian Plate by an ocean. The Proterozoic Aravalli-Delhi orogenic belt in northwest India is similar to the younger Himalayan-type orogenic belts of the Mesozoic-Cenozoic era (of the Phanerozoic) in terms of component parts and appears to have passed through a near-orderly Wilson supercontinental cycle of events. The range rose in a Precambrian event called the Aravalli-Delhi Orogen. The Aravalli Range is a northeast-southwest trending orogenic belt located in the northwestern part of Indian Peninsula. It is part of the Indian Shield that formed from a series of cratonic collisions.^[11] In ancient times, Aravalli were extremely high but since have worn down almost completely from millions of years of weathering, whereas the Himalayas, young fold mountains, are still continuously rising. Aravalli have stopped growing higher due to the cessation of upward thrust caused by the tectonic plates in the Earth's crust below them. The Aravalli Range joins two of the ancient Earth's crust segments that make up the greater Indian craton, the Aravalli Craton which is the Marwar segment of Earth's crust to the northwest of the Aravalli Range, and the Bundelkand Craton segment of the Earth's crust to the southeast of the Aravalli Range. Cratons, generally found in the interiors of tectonic plates, are old and stable parts of the continental lithosphere that have remained relatively undeformed during the cycles of merging and rifting of continents.[1,2,3]



Volcanic arc and geological process of undersea subduction during tectonic collision



Global convergent boundary of plate margins

It consists of two main sequences formed in the Proterozoic eon, metasedimentary rock (sedimentary rocks metamorphosed under pressure and heat without melting) and metavolcanic rock (metamorphosed volcanic rocks) sequences of the Aravalli Supergroup and Delhi Supergroup. These two supergroups rest over the Archean Bhilwara Gneissic Complex basement, which is a gneissic (high-grade metamorphism of sedimentary or igneous rocks) basement formed during the archean eon 4 Ga ago. It started as an inverted basin, that rifted and pulled apart into granitoid basement, initially during Aravalli passive rifting around 2.5 to 2.0 Ga years ago and then during Delhi active rifting around 1.9 to 1.6 Ga years ago. It started with rifting of a rigid Archean continent banded gneissic complex around 2.2 Ga with the coexisting formation of the Bhilwara aulacogen in its eastern part and eventual rupturing and separation of the continent along a line parallel to the Rakhabdev (Rishabhdev) lineament to the west, simultaneous development of a passive continental margin with the undersea shelf rise sediments of the Aravalli-Jharol belts depositing on the attenuated crust on the eastern flank of the separated continent, subsequent destruction of the continental margin by accretion of the Delhi island arc (a type of archipelago composed of an arc-shaped chain of volcanoes closely situated parallel to a convergent boundary between two converging tectonic plates) from the west around 1.5 Ga. This tectonic plates collision event involved early thrusting with partial obduction (overthrusting of oceanic lithosphere onto continental lithosphere at a convergent plate boundary) of the oceanic crust along the Rakhabdev lineament, flattening and eventual wrenching (also called strike-slip plate fault, sideways horizontal movement of colliding plates with no vertical motion) parallel to the collision zone. Associated mafic igneous rocks show both continental and oceanic tholeiitic geochemistry (magnesium and iron-rich igneous rocks) from phanerozoic eon (541–0 million) with rift-related magmatic rock formations.^[12]

The Aravalli-Delhi Orogen is an orogen event that led to a large structural deformation of the Earth's lithosphere (crust and uppermost mantle, such as Aravalli and Himalayas fold mountains) due to the interaction between tectonic plates when a continental plate is crumpled and is pushed upwards to form mountain ranges, and involve a great range of geological processes collectively called orogenesis.^{[13][14]}

Minerals

The archean basement had served as a rigid indenter which controlled the overall wedge shaped geometry of the orogen. Lithology of area shows that the base rocks of Aravalli are of Mewar Gneiss formed by high-grade regional metamorphic processes from preexisting formations that were originally sedimentary rock with earliest life form that were formed during the archean eon, these contain fossils of unicellular organism such as green algae and cyanobacteria in stromatolitic carbonate ocean reefs formed during the paleoproterozoic era.^[4,5,6] Sedimentary exhalative deposits of base metal sulfide ores formed extensively along several, long, linear zones in the Bhilwara aulacogen or produced local concentration in the rifted Aravalli continental margin, where rich stromatolitic phosphorites also formed. Tectonic evolution of the Aravalli Mountains shows Mewar Gneiss rocks are overlain by Delhi Supergroup type of rocks that also have post-Aravalli intrusions. Metal sulfide ores were formed in two different epochs, lead and zinc sulfide ores were formed in the sedimentary rocks around 1.8 Ga years ago during Paleoproterozoic phase. The tectonic setting of zinc-lead-copper sulfides mineralisation in the Delhi supergroup rocks in Haryana-Delhi were formed by mantle plume volcanic action around one billion years ago covering

Haryana and Rajasthan during the mesoproterozoic. In the southern part of the Aravalli supergroup arc base metal sulfides were generated near the subduction zone on the western fringe and in zones of back-arc extension to the south-east. Continued subduction produced tungsten-tin mineralisation in S-type (sedimentary unmetamorphosed rock), felsic (volcanic rock), and plutons (crystallised solidified magma). This includes commercially viable quantities of minerals, such as rock phosphate, lead-zinc-silver mineral deposits at Zawar, Rikhabdev serpentinite, talc, pyrophyllite, asbestos, apatite, kyanite and beryl.^{[15][16]}

Mining

Mining of copper and other metals in the Aravalli range dates back to at least the 5th century BCE, based on carbon dating.^{[17][18]} Recent research indicates that copper was already mined here during the Sothi-Siswal period going back to c. 4000 BCE. Ancient Kalibangan and Kunal, Haryana settlements obtained copper here.^[19]

Geographical features



The Aravalli Range, seen from the range's highest point at Guru Shikhar, in Rajasthan.

The Indian Craton includes five major cratons. Cratons are part of continental crust made up of upper layer called platforms and older bottom layer called basement rocks. shields are part of a craton where basement rock crops out at the surface and it is the relatively oldest and most stable part that are undeformed by the plate tectonics. The Aravalli Craton (Marwar-Mewar Craton or Western Indian Craton) covers Rajasthan as well as western and southern Haryana. It includes the Mewar Craton in the east and Marwar Craton in the west. It is limited by the Great Boundary Fault in the east, the Thar desert in the west, Indo-gangetic alluvium in the north, and the Son River-Narmada River-Tapti River basins in the south. It mainly has quartzite, marble, pelite, greywacke and extinct volcanos exposed in the Aravalli-Delhi Orogen. Malani Igneous Suite is the largest in India and third largest igneous suit in the world.^{[20][21]} The uniqueness of the geological feature of Malani Igneous Suite at Jodhpur prompted the Geological Survey of India to declare the site as a National Geological Monument.^[22]

Tectonic-stratigraphic evolution

Tectonic-stratigraphic evolution of the Aravalli Range:^[20]

- Neoproterozoic: Marwar Group
- 500–550 Ma: Malani Igneous Suite
- 720–750 Ma: Sindhrath/Punagarh Group
- 800–850 Ma: Sirohi Group
- 900 Ma: Erinpura granite
- Mesoproterozoic: Delhi Supergroup
- 1100–900 Ma: South Delhi fold belt
- 1600–1450 Ma: North Delhi fold belt
- Paleoproterozoic: Hindoli Group
- 1800–1700 Ma: Sandmata Complex
- 2200–1800 Ma: Aravalli Supergroup and mineralised basin at Rajpura-Dariba
- Neoproterozoic (2900–2600 Ma): Mangalwar Complex with Bhilwara Group
- Mesoarchean (3300–3000 Ma): Mewar gneiss with Jagat Supergroup

Stratigraphic classification

The stratigraphic classification of the Aravalli Range can be divided into the following parts (north to south direction):

- The Archean basement is a banded gneissic complex with schists (medium grade metamorphic rock), gneisses (high grade regional metamorphic rock), composite gneiss and quartzites. It forms the basement rock for both the Delhi Supergroup and the Aravalli Supergroup.
- Aravalli Supergroup: The Aravalli supergroup passes through Rajasthan state, dividing it into two halves, with three-fifths of Rajasthan on the western side towards the Thar Desert and two-thirds on the eastern side consisting of the catchment area of Banas and Chambal rivers bordering the state of Madhya Pradesh. Guru Shikhar, the highest peak in the Aravalli Range at 5,650 feet (1,720 m) in Mount Abu of Rajasthan, lies near the south-western extremity of the Central Aravalli range, close to the border with Gujarat state. The southern Aravalli Supergroup enters the northeast of Gujarat near Modasa where it lends its name to the Aravalli district, and ends at the centre of the state at Palanpur near Ahmedabad.
 - Champaner Group is a rectangular outcrop composed of subgreywacke, siliceous phyllite, pelitic schist, quartzite and pertomict conglomerate.
 - Lunavada Group is a polygon area in the south of the Aravali Orogen composed of greywacke-phyllite
 - Jharol Group is spread over 200 km² area with average width of 40 km carbonate-free phyllite and arenite with turbidite facies and argillaceous rocks.
 - Udaipur Group is a thick accumulation of greywacke-phyllite basement overlain by dolomite.
 - Debari Group consists of Carbonates, Quartzite, and Pelitic rocks which are overlain by the Delwara group.
 - Delwara Group is spread over a 500 km² area with average thickness of 500 m and includes basement orthoquartzite overlain by volcanic conglomerate.[7,8,9]
 - Unconformities
 - Mangalwar/Sandmata Complex and Mewar Gneiss with enclaves of the Jagat group
- Delhi Supergroup
 - Alwar Group with arenaceous and mafic volcanic rocks
 - Delhi Ridge, in the north
 - Haryana Aravalli ranges, in the west
 - Tosham Hill range basement rocks include quartzite with chiastolite, the upper layers of quartz porphyry ring dyke, felsite, welded tuff and muscovite biotite granite rocks which have commercially nonviable tin, tungsten and copper. The Tosham Hill range, west of Bhiwani in Haryana, is the northernmost end of the Aravalli range. A northeastern extension of the Aravalli extends to the national capital of India also. Locally known as a ridge it diagonally traverses to the South Delhi (hills of Asola Bhatti Wildlife Sanctuary), where at the hills of Bandhwari, it meets the Haryana Aravalli range consisting of various isolated hills and rocky ridges passing along the southern border of Haryana.^[23]
 - Madhogarh hill
 - Satnali hill
 - Nuh-Ferozepur Jhirka hill range, runs along Haryana-Rajasthan border from Nuh to the south of Ferozepur Jhirka.
 - Rajasthan Alwar range, in the east
 - Ajabgarh Group – Kumbhalgarh Group with carbonate, mafic volcanic and argillaceous rocks
 - Raialo Group with mafic volcanic and calcareous rocks

Human history

The Aravalli Range has been site of three broad stages of human history, early Stone Age saw the use of flint stones; mid-Stone Age starting from 20,000 BP saw the domestication of cattle for agriculture; and post Stone Age starting from 10,000 BP saw the development of the Kalibangan civilization, 4,000 years old Aahar civilization and 2,800 years old Gneswar civilization.

Tosham hills Indus civilization mines

The Tosham hills have several Indus Valley civilization sites in and around the hill range as the area falls under copper-bearing zone of Southwest Haryana and Northeast Rajasthan of Aravalli hill range.^{[24][25]}

Investigation of IVC network of mineral ore needs for the metallurgical work and trade shows that the most common type of grinding stone at Harappa is of Delhi quartzite type found only in the westernmost outliers of the Aravalli range

in southern Haryana near Kaliana and Makanwas villages of Bhiwani district. The quartzite is red-pink to pinkish grey in colour and is crisscrossed with thin haematite and quartz filled fractures with sugary size grain texture.^{[26][27]}

Ravindra Nath Singh and his team of Banaras Hindu University carried out ASI-financed excavations of Indus Valley civilization site on the grounds of the Government School in Khanak, during 2014 and 2016. They found early to mature Harappan phase IVC materials, pottery, semiprecious beads of lapis lazuli, carnelian and others. They also found evidence of metallurgical activities, such as crucibles (used for pouring molten metal), furnace lining, burnt floor, ash and ore slugs. Ceramic petrography, metallography, scanning electron microscope (SEM, non-destructive, surface images of nanoscale resolution), energy-dispersive X-ray spectroscopy (EDXA and EDXMA non-destructive, qualitative and quantitative elemental composition) and transmission electron microscopy (TEM, destructive method) scientific studies of the material found prove that the Khanak site was inhabited by the IVC metal-workers who used the locally mined polymetallic tin, and they were also familiar with metallurgical work with copper and bronze. The lowest level of site dates back as far the pre-Harappan era to Sothi-Siswal culture (4600 BCE or 6600 BP) tentatively.^[28]

Ganeshwar sunari Cultural Complex^[10,11,12]

The Ganeshwar sunari Cultural Complex (GSCC) is a collection of third millennium BCE settlements in the area of the Aravalli Hill Range. Among them, there are similarities in material culture, and in the production of copper tools. They are located near the copper mines.

"The GSCC is east of the Harappan culture, to the north-east of Ahar-Banas Complex, north/north west to the Kayatha Culture and at a later date, west of the OCP-Copper Hoard sites (Ochre Coloured Pottery culture-Copper Hoard culture). Located within the regions of the Aravalli Hill Range, primarily along the Kantli, Sabi, Sota, Dohan and Bondi rivers, the GJCC is the largest copper producing community in third millennium BCE South Asia, with 385 sites documented. Archaeological indicators of the GSCC were documented primarily in Jaipur, Jhunjhunu, and Sikar districts of Rajasthan, India ..."^[29]

Pottery found in the area include incised ware, and reserved slipware.

There are two main type sites, Ganeshwar, and Sunari, in Tehsil Kot Putli, Jaipur District (Geo coordinates: N 27° 35' 51", 76° 06' 85" E).

Environment



A lake nested within Aravali Hills.



Aravali Hills near Pushkar.

Climate

The Northern Aravalli range in Delhi and Haryana has humid subtropical climate and hot semi-arid continental climate with very hot summers and relatively cool winters.^[30] The main characteristics of climate in Hisar are dryness, extremes of temperature, and scanty rainfall.^[31] The maximum daytime temperature during the summer varies between 40 and 46 °C (104 and 115 °F). During winter, its ranges between 1.5 and 4 °C.^[32]

The Central Aravalli range in Rajasthan has an arid and dry climate.

The Southern Aravalli range in Gujarat has a tropical wet and dry climate

Rivers

Three major rivers and their tributaries flow from the Aravalli, namely Banas and Sahibi rivers which are tributaries of Yamuna, as well as Luni River which flows into the Rann of Kutch.

- North-to-south flowing rivers originate from the western slopes of the Aravalli range in Rajasthan, pass through the southeastern portion of the Thar Desert, and end into Gujarat.
 - Luni River, originates in the Pushkar valley near Ajmer, ends in the marshy lands of Rann of Kutch. It used to be one of the channel of the Saraswati River, as a result its banks have several Indus Valley civilisation sites including Lothal.
 - Sakhi River, ends in the marshy lands of Rann of Kutch.
 - Sabarmati River, originates on the western slopes of Aravalli range of the Udaipur District, end into the Gulf of Khambhat of the Arabian Sea.
- West to north-west flowing rivers originate from the western slopes of the Aravalli range in Rajasthan, flow through semi-arid historical Shekhawati region and drain into southern Haryana. Several Ochre Coloured Pottery culture sites, also identified as late Harappan phase of Indus Valley civilisation culture,^[33] have been found along the banks of these rivers.
 - Sahibi River, originates near Manoharpur in Sikar district flows through Haryana and meets its confluence with the Yamuna in Delhi where it is called Najafgarh drain, along with its following tributaries:^{[34][35][36][37]} Masani barrage, is an important wildlife area.
 - Dohan river, tributary of the Sahibi River, originates near Neem Ka Thana in Sikar district).
 - Sota River, tributary of the Sahibi River with which it merges at Behror in Alwar district.
 - Krishnavati river, former tributary of Sahibi river, originates near Dariba copper mines in Rajsamand district of Rajasthan, flows through Patan in Dausa district and Mothooka in Alwar district, then disappears in Mahendragarh district in Haryana much before reaching Sahibi River. It previously was a tributary to the Sahibi and part of its present canalised channel is called the Outfall Drain No. 8. Many important wetlands lie in its paleochannel, including Matanhail, Chhuchhakwas-Godhari, Khaparwas Wildlife Sanctuary, Bhindawas Wildlife Sanctuary, Sarbashirpur, Sultanpur National Park, Basai and The Lost Lake (Gurugram).
- West to north-east flowing rivers, originating from the eastern slopes of Aravalli range in Rajasthan, flow northwards to Yamuna.
 - Chambal River, a southern-side tributary of Yamuna River.
 - Banas River, a northern-side tributary of Chambal River.
 - Berach River, a southern-side tributary of Banas River, originates in the hills of Udaipur District.
 - Ahar River, a right-side (or eastern side) tributary of the Berach river, originates in the hills of Udaipur District, flows through Udaipur city forming the famous Lake Pichola.
 - Wagli River, a right-side tributary of the Berach River.
 - Wagon River, a right-side tributary of the Berach River.
 - Gambhiri River, a right-side tributary of the Berach River.
 - Orai River, a right-side tributary of the Berach River.

Ecology

Wildlife corridors

The Great Green wall of India

"The Great Green Wall of Aravalli" is a 1,600 km long and 5 km wide green ecological corridor along Aravalli range from Gujarat to Delhi, it will be connected to Shivalik hill range and 1.35 billion (135 crore) new native trees will be planted over 10 years to rehabilitate the forest cover in this area. To be implemented on a concept similar to the Great Green Wall of Sahara in Africa, it will act as a buffer against pollution, 51% of which is caused by the industrial pollution, 27% by vehicles, 8% by crop burning and 5% by diwali fireworks.^[38]

Northern Aravalli leopard and wildlife corridor



Charging Indian leopard.

The Sariska-Delhi leopard wildlife corridor or the Northern Aravalli leopard wildlife corridor is a 200 km long important biodiversity and wildlife corridor which runs from the Sariska Tiger Reserve in Rajasthan to Delhi Ridge.^[39]

This corridor is an important habitat for the Indian leopards and jackals of Aravalli. In January 2019, the Wildlife Institute of India announced that they will undertake the survey of leopard and wildlife, using pugmarks and trap cameras, subsequently, leopards and jackals will be tracked via the radio collars. Urban development, especially the highways and railways bisecting the Aravalli range and wildlife corridor in several places pose a great risk. Large parts of Aravalli are legally and physically unprotected, with no wildlife passages and little or no wildlife conservation work resulting in deaths of over 10 leopards in 4 years between January 2015 to January 2019.^{[40][41][42]}

The Haryana side of the Gurugram-Faridabad Aravalli hill forests lack availability of water due to which wild animals are seldom seen there. The Government of Haryana used drones for aerial surveys and dug 22 ephemeral pits in 2018 to store the rainwater which became dry during the summer months. In January 2019, the government announced the plan to make the pit perennial by connecting those with pipelines from the nearby villages.^[43]

Human activity, such as unplanned urbanization and polluting industrial plants, also pose a great threat. There is often reluctance and denial on part of the government officials of the presence of wildlife such as leopard so that the forest land can be exploited and opened up for the intrusive human development.^{[44][45][43]}

This habitat is under serious threat from the wrong actions of the Government of Haryana which in 2019 passed the amendment to the Punjab Land Alienation Act, 1900 (PLPA). Governor has given his assent for the act, but it has not yet been notified by the Haryana government, hence it is in limbo and has not officially become a law. This amendment will reduce the Haryana's Natural Conservation Zones (NCZs) by 47% or 60,000 acres from 122,113.30 hectares to only 64,384.66 hectares. This is in violation of multiple guidelines of the Supreme Court of India as well as "NCR Planning Board" (NCRPB) notification which states the original 122,113.30 hectares ecologically sensitive forest of South Haryana is a forest, "The major natural features, identified as environmentally sensitive areas, are the extension of Aravalli ridge in Rajasthan, Haryana and NCT-Delhi; forest areas; rivers and tributaries... major lakes and water bodies such as Badkhal lake, Suraj Kund and Damdama in Haryana sub-region".^[46] This area as part of Northern Aravalli leopard and wildlife corridor is an important habitat for the leopards in Haryana.[13]

II.DISCUSSION

Abdal khan is a prisoner of geography. A resident of Nimli village in Rajasthan's Alwar district, Khan, who claims to be over 100 years old, is mostly bedridden in his home nestled in the foothills of the Aravallis. He stays quiet most of the time, but a mention of the Aravallis triggers an outburst. "I have accompanied British officials on hunting tours on these hills. Where we are sitting now was once a thick forest," he says. There are only a few like him alive, who can remember the once ecologically rich Aravallis and also witnessed its gradual demise. His youngest daughter, Dini Bi, who is half his age, lives some 50 km north in Banban village of the same district, also located in the mountain range, which has

almost disappeared. While Khan laments the loss of forests, his daughter is not so mournful. “It was good when the mountain was there. But mining gave us jobs,” she says.

This is the chronology of the dying Aravallis. Within one generation, millions who once found it the axis of their sustenance, are now reconciled to the loss of one of the planet’s oldest physical features. This despite the fact that village after village have reported changes in the local ecology after the mountain range’s degradation, with significant impact on the people’s lives.

The account of Khan is a telling comment on the degradation the Aravallis due to mining. Though the Supreme Court banned mining in the range in 2002, unless cleared by the Union Ministry of Environment, Forest and Climate Change (MoEFCC), illegal mining has continued, sometimes on a scale even larger than that of legal mining operations. A 2018 report by Supreme Court-appointed Central Empowered Committee (CEC) says that 25 per cent of the Aravalli range has been lost due to illegal mining in Rajasthan since 1967-68 and over 10,300 hectares (ha) have been affected outside the lease boundary in the 15 districts where 80 per cent of the Aravallis are located.

“Extent of illegal mining in terms of percentage area exceeds 100 per cent in many cases, especially in respect of smaller mines allotted for minor mineral,” the report says, which was based on satellite images of 2008-2010. While the committee recommended the Rajasthan government immediately stop all mining activities outside the legally sanctioned mining leases and identify and prosecute those involved, experts and activists working to conserve the Aravallis rue the poor implementation of the laws on the ground. A 2017 Comptroller and Auditor General of India (CAG) report says 4,072 cases of illegal mining, transportation and storage of minerals have been registered between 2011-12 and 2016-17. Around 9.8 million tonnes of minerals were found to have been illegally excavated.

The Aravalli mountain range that spans four states—Gujarat, Rajasthan, Haryana and Delhi—was never continuous, but mining and construction activities have made it even more broken. Of 128 hills/hillocks of Alwar district in Rajasthan that were sampled from the total 2,269, it was observed that 31 hills/hillocks have vanished from the time the Survey of India topographic sheets were prepared in 1967-68, says the CEC report. The gaps were recorded by satellite pictures and verified on the ground.

“Just recently we witnessed a hillock in Mokhampura village on National Highway 8, some 70 km from Jaipur. Half of it is eroded and it will be completely lost in another year,” says Ambuj Kishore, programmes director at Association for Rural Advancement through Voluntary Action and Local Involvement, an organisation set up by the Rajasthan government to promote voluntary action for the state’s socio-economic development.

Degradation of Aravallis is also evident in the loss of forest cover. During 1972-75, the Aravalli districts in Rajasthan recorded 10,462 sq km of area under various categories of forest. By 1981-84, the forest cover reduced to 6,116 sq km, says a 2018 report by Delhi-based Rajiv Gandhi Institute for Contemporary Studies (RGICS).

Haryana has a similar story. Of its 22 districts, Aravallis are present in Mewat, Faridabad, Gurugram, Mahendragarh and Rewari, all of which are currently, or were till recently, heavily mined and have undergone rapid developmental and construction activities (see ‘Mountain of troubles’). In Gurugram’s Harchandpur village, the groundwater has severely depleted due to mining and stone-crushing units in surrounding areas and mushrooming of real estate projects in adjoining districts. Raja Ram Bhamla, a farmer of Harchandpur, says that two decades ago, water was available at a depth of about 10 m, but now one has to drill 150 m. “The Aravallis no longer provide fodder, nor bring rain. As a result, groundwater is depleting due to over-extraction and the fields are turning into a desert,” he says.

The depleting groundwater in Harchandpur has had another side-effect. It has triggered a termite epidemic. “The presence of water chokes the pores of the soil and kills termites. But when the soil becomes dry, termite attacks increase,” says O P Yadav, director of Central Arid Zone Research Institute, Jodhpur, Rajasthan.

The termite problem has, in turn, triggered changes in crop patterns. Earlier, farmers in Harchandpur grew pulses. But now they have shifted to water-intensive mustard and wheat because the water protects the crop from termites. But since the crops are water-intensive, the farmers extract more water from the ground and the vicious cycle is draining the groundwater.

Like Rajasthan, Haryana too is losing forest cover. A study by the Wildlife Institute of India (WII) said that while green cover has declined in Haryana between 1980 and 2016, human settlement has increased by 158 per cent, from 247 sq km to 638 sq km, in the same period. At the same time, the area taken up by the industries has gone up from nil to 46 sq km.

Government agencies themselves are party to Aravallis' destruction. In Manesar, over 16,000 fully grown trees on 23 ha of forestland were chopped off without permission between 2011 and 2013 to set up police lines, shows a 2018 RTI query filed by Ram Avtar Yadav, a farmer and former sarpanch of Manesar, Haryana. In fact, the police department has been acquiring forest land to build various residential and training complexes on land marked as "forest", without requisite permissions, over the years, alleges Yadav. A police training institute has been set up in Bhondsi village of Gurugram, for which over 4,500 trees were felled, even as the proposal from the police department for permitting the construction lies with the forest department.[14,15,16]

"Yes, we have noticed violations. The institute should not have come up without permission. They acquired the land from the village panchayat. The complaints have been sent to MoEFCC and action will be taken," Deepak Nanda, district forest officer, Gurugram, told Down To Earth. Yadav also points out that the boom of the real estate sector, especially in districts around Gurugram, has led to the laying of unwanted roads. "There are some areas where roads are already there but new roads are being built just to increase the value of the property," he says.

In Gujarat too, illegal mining in Banas-kantha, Sabarkantha and Aravalli districts—the three districts where the Aravalli range spans—has adversely affected the ecology. "The Balaram Ambaji sanctuary, a protected area, in Banaskantha too is bearing the brunt of mining," says Ashok Shrimali of Mines, Minerals & People, an Andhra Pradesh-based non-profit. Earlier, the hills across the four states provided rich habitat to wildlife—tigers, leopards, wolves, blackbucks, Indian gazelle, desert fox, the great Indian bustard, migratory common cranes, ducks, coots and pelicans. But now only the relicts are found at places like Ranthambhor, Sariska and Kumbhalgarh in Rajasthan.

Even the Delhi ridge, the last stretch of Aravallis, in the northern part of the capital, has been encroached upon. "The massive exploitation of the ridge has made it unrecognisable. Huge residential colonies, religious institutions, university campus and security force camps have been set up. This has made the landscape flat, like the plains," says Ravi Agarwal, director of Delhi-based non-profit Toxics Link. The ridge acts as lungs for the city's polluted air; helps maintain reserve of drinking water; and, protects it from desert sands blowing from Rajasthan.

In all the states, the depleting groundwater has fuelled the growth of invasive species that thrive on minimal water. "Indigenous trees have disappeared and there is a preponderance of kikar (*Julifora prosopis*)," says Bilal Habib, researcher at WII. "Unlike kikar, the indigenous varieties were broad-leaved, which retained more water and played a key role in the ecology of the mountains, helping in rain formation. When kikar spreads, the area is still green but it is a green desert," he adds. Meteorological department data shows that Alwar has not received average annual rainfall since 2009. "Sand dunes and desert vegetation have even become visible in certain parts of Haryana's Sohna town," he says.

Small wonder, when the Haryana government amended the century-old Punjab Land Preservation Act, 1900, on February 27, it faced public anger. The amendment opens up 25,000 ha of forest areas in the Aravallis for construction and mining. It also legitimises the illegal construction and mining that has already happened in the area. On February 28, environmental activists such as Chetan Agarwal, an independent environment policy analyst based in Faridabad, organised several protests in Gurugram and Faridabad against the legislation. The activists also went to the Supreme Court and on March 1, the court stalled implementation of the amendment.

Sweeping impact

The decline of the effectiveness of the Aravalli hills as a source of structural control for normal weather and climate can be gauged from the shrinking of the duration of rainy season (from the day of onset of monsoon to the day of its withdrawal)— from 101 days in 1973 to just 25 days in 2009, says Narpat Singh Rathore, former head of department of geography at Mohanlal Sukhadia University in Udaipur, in a 2009 study on the Aravallis.

Similarly, the total number of rainy days has declined from 60-80 days per year to 18-30 days.

According to a 2017 WII report, the hills checked the spread of the Thar Desert towards eastern Rajasthan, the Indo-Gangetic Plains, Haryana and western Uttar Pradesh. But the 2009 report by Rathore, which analysed remote sensing data of 1972-75, 1982-84, 1994-96, and 2005-07, reveals that the desert sand is drifting towards northeastern plains through 12 identified gaps in the Aravallis, extending from Magra hills in Ajmer district to Khetri-Madhogarh hills in Jhunjhunu district and northern-most hillocks in Mahendragarh district of Haryana, totalling 93 km. The study identifies Dungarpur-Banswar gap area on the Aravalli range, Upper Banganga Valley, Magra Area, Girwa-Gogunda tract, Jaisamand Lake area, Daragarh-Banara-Maja-Dariba area, Abu-Sirohi and Chappan hills of South Aravalli as "extremely most vulnerable".

A serious ecological impact of digging or mining to a great depth is puncturing of aquifers, which disturbs the water flow, results in drying of lakes and popping up of new ones. One such case has been seen in Faridabad, Haryana. The RGICS study says that Bharadwaj lake, apparently named after the contractor who was allotted the contract for red silica in that area, has been observed in the district. “The lake points towards a possibility of illegal mining. The Faridabad mining department, however, claims that no one named Bharadwaj was allotted a mining lease in that area. Several reports have also confirmed the vanishing of rivers like Banas, Luni, Sahibi, Indori and Sakhi, which originated in the Aravallis, says WII.

The denudation of forests along the northern and central Aravalli tracts is also increasing intensity of dust storms. Last year, for instance, several dust storms hit north-west India and were unusual in terms of intensity, frequency and character. While between 1980 and 2003, India saw nine deadly convective storms, which killed some 640 people, in the next 14 years—2003 to 2017—22 storms were recorded, which left some 700 dead. In 2018 alone, 50 such storms and 500 deaths were reported till July in northeast of Aravallis. So what is the way out?

Legal option

The developments so far indicate that legal route is, perhaps, the surest way to protect the Aravallis. The British were the first to recognise the importance of the range and declared parts of it as a reserve forest under the Indian Forest Act of 1878. Later, additional areas got protection under this Act. In 1900, the British enacted the Punjab Land Preservation Act (PLPA), which prohibited mining, clearing of forest or land for cultivation. This protection, however, applied only to a small portion of the Aravallis in Haryana, which was then part of the Punjab region.

After Independence, there were little legal efforts by successive governments to protect the mountain range. In the mid-1980s there were people’s movements to save the Delhi ridge. Non-profits like Kalpvriksh, the World Wide Fund for Nature (WWF) and Srishti spearheaded the public campaign. In Rajasthan, Rajinder Singh of Alwar-based non-profit, Tarun Bharat Sangh, led a movement to save the Aravallis from mining activities in 1988.

Though these awareness movements brought the issue in the public domain, it could not stop the rampant destruction.

So, the only way left was legal intervention, and a few landmark judgements attempted to offer respite. In 1985, environment lawyer M C Mehta filed a petition in the Supreme Court against the Union government, Haryana government, central and state pollution control boards and 65 stone crushing companies that were operating on the outskirts of Delhi. The Supreme Court slammed the Haryana government and asked it to relocate the industry.

In 1991, Tarun Bharat Sangh filed a petition in the apex court demanding a ban on the widespread illegal mining inside the Sariska Tiger Reserve area. The court appointed a committee headed by a former judge of the Rajasthan High Court to check the claims. The committee confirmed illegal mining, and in April, 1993, the Supreme Court imposed a ban on illegal mining in the protected areas. Though the judgement set a precedent for all cases related to mining in the protected areas, activists allege that mining is still going on in and around Sariska.

Taking note of these rulings, MoEFCC issued an unprecedented notification on May 7, 1992, known as “The Aravalli Notification”. This notification clearly prohibits the setting up of new industries, mining, deforestation as well as construction activities, including roads and laying of transmission cables, without the prior permission from MoEFCC. “This notification proved to be an important stepping stone to conserve the Aravalli range and the forests around it,” says Singh.

Ownership tangle

The destruction of the mountain range primarily has to do with land ownership and how various interest groups have tried to circumvent the law or disobey court orders to enable either mining or construction activities. On paper, a number of government agencies claim ownership rights. These include the forest department, the revenue department, the Central Public Works Department, the Delhi Development Authority and the Land and Development Office.

This situation has arisen ever since India enacted the Forest (conservation) Act in 1980 (FCA). Many state governments went on to de-notify forest areas and kept a sizeable part of forests out of the purview of FCA. That’s because if any state government wants to use forestland for non-forest purposes, it has to get the consent of MoEFCC, which is a laborious process.

In some cases, state governments have amended their own laws to accommodate diversion of land. For instance, the antecedents of the Haryana government’s February 27 amendment to PLPA can be traced to the case of R Kant & Co. In

1984, the Haryana government first de-notified PLPA lands and declared it as revenue land. Then it amended the Haryana Development and Regulation of Urban Areas Act, 1975 to convert more than 202 hectares of PLPA forestlands for commercial use. But Supreme Court put its foot down. In 2018, the court rejected this amendment and said that PLPA lands should be considered as forestland.

Despite the “Aravalli Notification” and the subsequent Supreme Court’s judgements, states have found ways to violate norms in more ways than one. Rajasthan, for instance, has been renewing the mining leases in the mountain range without taking clearances from MoEFCC. They are doing so by taking recourse in their defunct rules.

Since the states were defining forests to suit their needs and grant forestlands for non-forest uses, the Supreme Court, in the T N Godavarman v Union of India case in 1996, cleared the confusion and said “the word ‘forest’ must understood according to its dictionary meaning of the term irrespective of the nature of ownership and classification thereof”. The judgement stated FCA would be applied on every forest, irrespective of their nature of ownership or classification. The Supreme Court had then directed all state governments to identify all such areas.

But state governments have found a way to tweak these directions. “The Haryana government has come out with a list that includes only those areas which was under the forest department and left large chunks of forest areas that it wishes to use for non-forest purposes,” says Rahul Choudhary, a senior environmental lawyer.

The problem is that there are laws and judgements for state governments to enforce the rules. But this does not happen. Even as numerous cases are being fought in various courts, the destruction of the Aravallis continues unabated.

III.RESULTS

Indiscriminate quarrying and mining have flattened many mountains in the Aravalli Range which is thousands of years old, leaving the national capital and its surroundings vulnerable to the encroaching desert. Bharat Dogra gives a first-hand report and suggests remedial measures

A research study conducted recently by the Central University of Rajasthan has found that over 31 hills in the upper Aravalli Range have disappeared over the last 20 years or so. They ranged between 200 and 600 meters above sea level. Many more hills in the lower and middle levels of the ancient range are similarly affected. This alarming disappearance is largely due to indiscriminate mining and urbanisation.

It is shocking indeed that hills which had existed for tens of thousands of years can vanish so fast. This will not only have very adverse environmental impact, it also poses a danger for the national capital region (NCR) and the fertile farmland adjacent to it in Haryana and Western UP, as the region will be lashed even more by sand- and dust-laden winds from desert areas once the protective cover of the hills is gone.

This is not an isolated case. The ecologically crucial hills of the Bundelkhand Region have also seen similar ravaged by indiscriminate mining in Mahoba and Chitrakut Districts and other areas. These mining belts further endanger water sources in an area already affected by water scarcity and are also responsible for shocking exploitation of workers, as witnessed by this writer, who visited some of these mining areas as a member of a team of the National Human Rights Commission.

The Aravalli Mountain Range extends for about 670 km from Delhi towards Ahmedabad, most of it lying in Rajasthan and Haryana. This is one of the oldest geological formations in the entire world. Yet it has taken only a few decades to damage it extensively, flattening mountains which for thousands of years prevented the encroachment of the Thar Desert. The single most responsible factor is indiscriminate mining and quarrying.

A while back, I studied the impact of stone mining in several villages of the NeemKa Thana area in Sikar District. Villagers shared with me the shocking tale of ruined farmland, pastures and water sources. The Kasavati River had almost vanished. Blasting led to cracks in houses and stones being hurled dangerously far and wide. There had even been some deaths due to this. Not just quarry workers, several villagers too suffered from silicosis and other dust-related diseases. As their livelihoods based on farms and pastures were eroded and daily life became dangerous, with houses

becoming unsafe and water sources being destroyed or depleted, people justifiably felt that their right to life was being threatened. However, when they protested against this, they faced lathi blows and arrests.

The villagers told me that an activist who opposed all this, Pradeep Sharma, hailing from a family of freedom fighters, had been murdered. Recently, there have been reports from other parts of the Aravalli Region that even police officers who tried to check indiscriminate mining were not spared. DSP Surendra Singh was mowed down by a stone dumper just a few weeks before he was due for retirement in Nuh District of Haryana. The fact that those indulging in illegal mining in these areas do not hesitate to attack even police officials speaks volumes of their power and high connections.

The police say they have registered a large number of cases of illegal mining and initiated action. The judiciary has also been quite active, and several strong orders over the recent years testify to its efforts to check illegal mining and encroachments to protect the Aravallis. Several citizen groups, environmental and wildlife groups too have been active on this front. Despite all this, ecological havoc in the Aravallis continues.

The issue needs to be looked at from the perspective of social justice too. Workers have been frequently employed in quarries, mines and stone crushers in exploitative and unhealthy conditions. Organisations like the Delhi-based Bonded Labor Liberation Front and its Alwar branch have rescued several workers caught in bondage.

Last year, in the middle of adverse weather and pandemic-related difficulties, more than 10,000 houses were demolished in Khori, Faridabad District, in the name of removing encroachments, causing immense distress to working class people. A better approach would have been to make the communities living in these areas responsible for greening some of the surrounding land, possibly in return for some remuneration drawn from the Afforestation budget, thereby contributing to protection of the environment as well the shelters and livelihoods of weaker sections. No one can green an area as well as the people living on the spot, particularly women.

Similarly, when parks and sanctuaries were created in the Aravalli Region, it often involved the displacement of people (particularly tribal communities) or substantial erosion of their livelihood prospects. Why not instead provide them opportunities to protect wildlife and habitats as additional livelihood options? In areas that have been devastated by mining and then abandoned, why not launch ecology rehabilitation drives that can provide satisfactory livelihoods to people?

There are several badly degraded forests in the region. Tribal communities and various other weaker sections can be involved in regeneration of these forests. Initially, they can be paid for their work and, later, given rights over sustainably harvested minor forest produce from the regenerated forests, on the understanding that they protect the forests and their fauna and flora.[17,18,19]

Another consideration is that of making available construction materials on a sustainable basis. While areas which have suffered heavy ecological damage due to over-exploitation in the past deserve to be completely rested from mining at least for some years, and ecology-regeneration schemes implemented there, in other areas, systems should be created for sustainable mining of stones or minerals in limited quantities, the amounts being decided in close consultation with local people. These limits should be respected even if there is increased market demand for construction materials at some periods. The technology used for mining should be least ecologically disruptive, even at the cost of being slow and labour-intensive. In fact, labour-intensive methods should be given preference, as they will generate employment.

Clearly, such choices can be made only in conditions of real decentralization, with more power being vested with gram panchayats and gram sabhas. A share of the earnings from mining should also be set aside for ecological rehabilitation.

IV.CONCLUSION

With the curbing of the mining mafias, the criminalisation of areas where they operate can also be avoided. Such a developmental path is relevant not just in the context of Aravalli Hills, but also with reference to other mountain ranges

such as those in the Bundelkhand Region which are being increasingly threatened by indiscriminate mining and deforestation.[20]

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