7th INTERNATIONAL CONFERENCE ON GEOSCIENCES EDUCATION

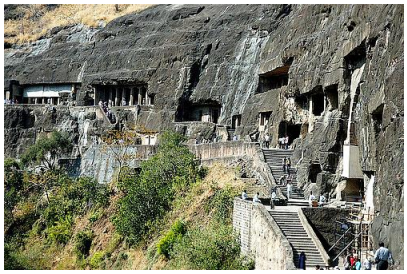
Hyderabad, September 5-9, 2014

Post-conference Field Trip No. 2

Deccan Volcanic Province – Lonar Crater – Ajanta Ellora

September 10-14, 2014





Post-conference Field Trip No. 2

Deccan Volcanic Province – Lonar Crater – Ajanta Ellora

- *Duration : September 10-14, 2014*
- *Approximate cost : Rs. 20,000[1,2]*
- *Last date to register : July 30, 2014*
- *Note: A minimum of 10 participants needed to conduct the field trip.*

[1] To be sent to bank account details given at the end of this document.

[2] Cost includes travel from/to Hyderabad, vegetarian food and accommodation

SCHEDULE

09-9-2014: Depart Hyderabad at 22.00 hours by train to Aurangabad

10-9-2014: Arrive Aurangabad at 07.30 hours

10-9-2014
To : Field trip to Ajanta - Ellora, Lonar Crater and Deccan Volcanics*
13-9-2014

13-9-2014: Depart Pune at 22.20 hours

14-9-2014: Arrive Hyderabad at 08.00 hours

Deccan Volcanic Province – Lonar Crater – Ajanta Ellora

Field Guide

Introduction

The Deccan Volcanics are one of the best-preserved, most extensive continental flood basalts in the world. They are also referred to as Deccan Traps in geological literature. The term "Deccan Trap" was coined by W.H. Sykes in 1833 and it is derived from a Sanskrit word d*akshin* meaning south or southern and a Swedish word *Trapp/ Trappa* meaning stair. The term was aimed to describe the step like or terrace like topography peculiar to this terrain. The aerial extent of these basalts is about half a million square kilometers, covering major parts of western and central India; the estimated volume is about 512,000 cubic km.

Geographically, the Deccan Volcanic Province (DVP) is divided into various subprovinces – the Main Deccan Province, the Malwa Traps, the Saurashtra and Kutch Traps and the Mandla Traps. The basalts and the associated volcanic suite of rocks were emplaced during 69 - 63 Ma, with the major volcanic pulse at 66.9$\pm$ 0.2 Ma (Mahoney et al 2002; Hooper, 2010). This stupendous volcanism erupted close to the Cretaceous-Tertiary (K/T) boundary, related to the mass extinction of dinosaurs.

Information on the geology of this vast province was meager till ~1970. Following the Koyna earthquake of 1967, geoscientists from various organizations carried out extensive geological mapping and geophysical studies. Bulk of the DVP is made up of pahoehoe and a`a flows, having varied a thickness (5-30 m). Some flows are transitional in nature. The maximum aggregate thickness is ~2000 m in the Western Ghats (the *Sahyadri).* They are sub-horizontal, with a gentle easterly / southeasterly gradient. The basalts are quartz normative, low-K tholeiites; plagioclase (labradorite-bytownite), augite, occasional olivine and secondary zeolites are the main mineral constituents.

The Deccan basalt flows have been divided into four Subgroups and nine Formations based on lithostratigraphic studies, and into three Subgroups and 11 formations based on geochemical studies. The classification of the DVP is based on broad lithological characters such as the presence of interflow horizons and physical characters of the flows. Detailed systematic work by the Geological Survey of India (Godbole et al., 1996) and chemostratigraphic work carried out in the late 1980's (Subbarao and Hooper, 1988) have led to a generalized litho- and chemo-stratigraphy of the Province.

The erosional landscape developed on the Deccan basalts form flat-topped hills and ridges separated by broad, v-shaped valleys. The Western Ghat escarpment is one of the main geomorphological features. It parallels the west coast of India and is nearly 1600 km long. It constitutes the major water divide between the short, west-flowing rivers and the long, older, east-flowing rivers of the upland plateau.

The present-day landform is a relict one, where rivers are minor elements when compared to denudational surfaces, as the present rivers are not effective in shaping the landscape. These surfaces are covered with vertisols and colluvial deposits of variable thickness. Laterite is developed on the highest surfaces (> 1200 m above msl) in the southern part and may be seen in Mahabaleshwar, Panchgani and Kas Plateaux.

Field Trip

Day 1:

Introductory lecture after breakfast

Depart at 10am.

Visit the rock cut caves at Ellora and Daulatabad fort. If time permits other interesting archeological sites in and around Aurangabad. (Distance – 32 km, travel time 35 min)
The rock cut architecture had its origin in north eastern India around 250 B.C. There is nearly 1200 rock cut caves in India, of which ~1000 are located in Maharashtra. The rock sut caves excavated in the basalt of Maharashtra date back to 1st century B.C., reaching its zenith in 5th century A.D and ended with the caves of Ellora in Aurangabad.

The Ajanta Caves are located just outside the village of Ajiṇṭhā in Aurangabad district. There are 31 rock-cut cave monuments, which date from the 2nd century BC, carved in compound pahoehoe type flows. Ajanta caves, a secluded retreat for the Buddhist monks was carved out of deep curved mountain side, lying deep in Sahyadri hills in 200 BC and remains shrouded in obscurity for more than millennia from 650 AD when it was abandoned in favor of Ellora caves. The caves include paintings and sculptures considered to be masterpieces of both Buddhist religious arts (which depict the Jataka tales). It is interesting to note that the sculptors and architects preferred the compound/pahoehoe flow-typesto a'a flows. Flow units can be demarcated in the famous Kailas rock cut temple in Ellora, where the trunks of the monolithic elephants have been dislodged due to differential weathering at the unit contacts.

Since 1983, the Ajanta and Ellora Caves have been a UNESCO World Heritage Site. The World Heritage Sites of Ajanta and Ellora Caves are testimony to the fact that these are the unsurpassed rock cut caves not only in India but also in the whole world. Ellora Caves are an example of perfect religious harmony. The 34 caves of Ellora built from 350 AD to 700 AD belong to people of three different faiths Buddhists, Hindus and Jainism. The 12 caves on the South are of Buddhists and 17 caves in center are dedicated to the Hindus while five caves to the North belong to the Jain's.

Lunch at Ellora

Visit Daulatabad fort on the way back.

Return by evening ~5pm.

Halt at Aurangabad.

Day 2:

Leave for Lonar at 8.00 am Aurangabad to Lonar ~136km, ~3hrs travel time.

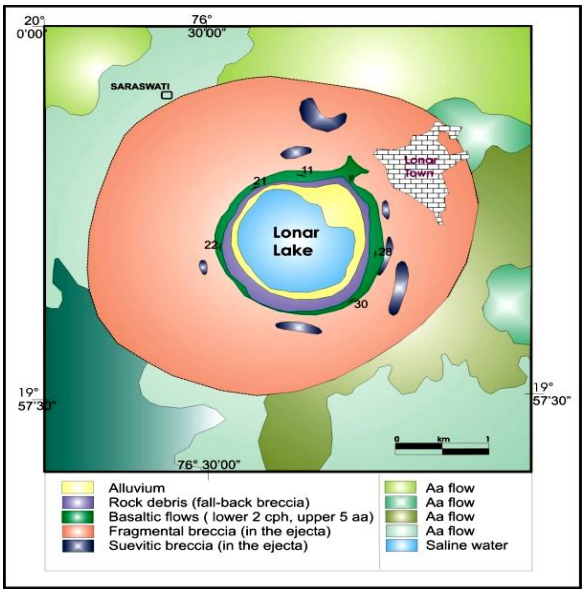
Feld study 5hrs

Lunch at Lonar

Study of Meteor impact crater at Lonar. Lonar is about 90 km southeast of Buldana. Lonar Lake is a nearly circular crater, suspected to have developed due to impact of a large meteorite on Deccan Basaltic rocks. The presence of shatter cones, impact deformation of basalt layers comprising its rim, shocked breccia inside the crater, and non-volcanic ejecta blanket surrounding the crater are further proof of the impact origin of

Lonar crater. This is supposed to be the world's third largest crater, with an average diameter of 1710 m, average rim height of 40 m and depth of 230 – 245 m. It has its genesis nearly 50,000 years ago, when a 2 million-ton meteorite impacted the earth to create a depression. $^{40}Ar/^{39}Ar$ measurements on the melt rock samples from the Lonar crater, which has yielded an age of 570 ± 47 ka(Jourdan, 2011)which is much older compared to the non isotopic investigations by earlier workers(ca. 12–62 ka).The circular depression bears a saline water lake in its central portion. Lonar Crater has been declared a "Geological monument"

On the inner slope of the crater walls, five such individual flows are exposed; two compound pahoehoe flows and three a`a flows, with low to moderate (~ 5°-20°) dips, flows dipping out from crater wall. The lava flow sequence is capped by several metre thick ejecta blanket. The thicknesses of the individual basalt flows range from about 10 to 30 m in thickness; the different flows usually separated by red boles (i.e. interflow horizons). The Deccan basalts are tholeiitic in nature plagioclase (labradorite), and pyroxene (augite and pigeonite) being the predominant mineral phases.



Geological sketch map of Lonar crater and its neighborhood (Sabale and Sen, 2005)

Return to Aurangabad by Aurangabad by 7 pm.

Halt at Aurangabad

Day 3:

Leave at 8.00 am for Pune via Ahmednagar road
Study of geology en-route. Those interested can visit Shirdi temple.

Study Vambori ghat section- Section of a`a flows, giant palgiocalse basalt and pahoehoe flows in which lava channels have been delineated
Study of lava distributary channel along Vambori -Gunjale, bk to Aurangabad road
(2 – 3 hrs time)

The term lava flow has been used in general to describe an individual outpouring of lava large enough to map. Deccan lava flows have been classified into a`a and pahoehoe, based on their surface morphology and mode of emplacement. Terms like simple flow

and compound flow has also been used to describe the lava flows. The ghat section exposes a`a flows, giant phenocryst basalt and pahoehoe flows.

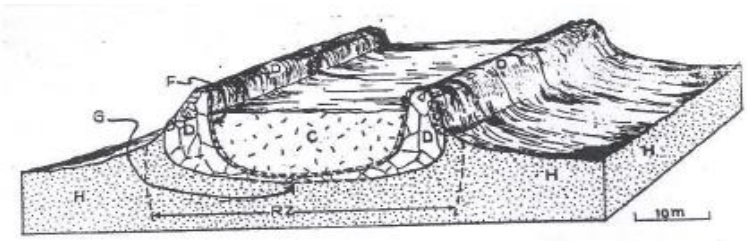
A`a flows generally have a rubbly, vesicular, clinker surface composed of blocks of varied size. This clinker crust is also referred to as flow top breccia/fragmentary top. This has developed because of the high strain rate. The vesicles are also stretched into irregular shapes. Within the massive interior of the flow, partially resorbed fragments of the crust are common. An impersistent zone of clinker marks the basal portion.

Gaint plagioclase basalt-The flows with large (>2-3 mm) plagioclase phenocrysts have been referred to as megacryst flows or giant plagiocale basalt. This textural criterion is useful in correlating flows, as it is easily identifiable in the field. In the DVP, many such GPBs have been identified at different stratigraphic levels. The GPB exposed in this ghat section (Photo-1), separates the lower dominantly pahoehoe flows (Ratangarh Formation) from the a`a pile (Indrayani Formation).

Pahoehoe flows are mostly compound in nature.In geometr, all the flow units are bun shaped units with more or less flattened base and inflated tops. The presence of pipe amygdules at the base and a zone of spherical vesicles towards the top typify an individual unit. (Photo 2a) The top surface of the units form reddened glassy crusts due to chilling. Crudely developed ropes and cords are seen on the reddened crust (RC) at places. (Photo 2b)Squeeze ups, wedge shaped features inter connecting lobes and units and vesicle cylinders, indicating escape of stream of volatiles are also seen at places.

Lava tubes and channels are commonly found in pahoehoe flows and have been identified from modern lava flows where they are known to provide an insulated and efficient mode of transport of the lava flows. Lava propagation has been explained to result from growth by sequential but discontinuous lobe-by-lobe emplacement. Due to repeated branching of toes and lobes that grow endogenously a network of small lava tubes are formed.

In ancient provinces like DVP, due to high degree of erosion it is difficult to identify the intrinsic structure and morphology of the lava features. Nonetheless, detailed remote sensing interpretations supported by systematic and extensive field studies have resulted in the identification of remnants of segments of lava channels and tubes in the DVP. Sinuous, meandering lava channel can be clearly identified here and can be traced from the northern edge of Vambori ghat, upto Gunjale. The low ridges have a depression in the center, with hard-indurated levees forming the margins. They are roughly circular in cross section, having a saucer shaped base. This lava channel is spectacular, resembling a lava river(Photo-3). One can also see development of calc tufa at the edge of the levee of this lava channel, resembling a fall tufa or cliff drape (Photo-4)



Schematic diagram showing the lava channel in cross section. C-core, D-levee, R-rim of glassy basalt, RZ- zone of reddening and induration.(Thorat, 1996)

Photo 1

Photo 2a

Photo 2b

Photo 3

 *Photo 4*

Visit to Gargoti Museum at Sinnar: One of the best museums which exhibits all the different zeolites found in the Deccan basalts.

Zeolites are a family of silicate minerals (hydrated alumino-silicates). They occur as beautiful crystalline minerals of various forms and colour. Zeolites in the Deccan Volcanics occur as secondary minerals in gas bubble cavities and crevices.

They are known for their beauty and by far transcend in quality and quantity when compared to those found in other countries. Pune has been the collecting center for Indian zeolites for years. There were many quarries around Pune that produced good specimens. Several varieties of zeolites ranging from heulandite, stilbite, scolecite, mordenite are found in quarries around Pune, Nasik, Aurangabad and Mumbai. Molybdenum-, V-, Cu-bearing ones like powellite, cavanzite and woodwardite are also found in a few places. The Wagholi quarry complex off Ahmednagar Road is one of the localities in the world where excellent specimens of cavanzite are found. Zeolites are generally collected from quarries, which expose the mineralized pockets/cavities.

Geology en-route. Dykes intruding lava pile, interesting geomorphic features etc.

Sinnar to Pune – 181km, ~ 4 hrs.
Ahmednagar to Pune - 121 km, ~2 hrs, 20 min
Geology enroute.
Tea break
Reach Pune around 7 pm.
Halt at Pune

Day 4:

Depart for Mahabaleshwar at 8.30 am after breakfast.

Visit to Satara- Mahabaleshwar to study the great western escarpment and Laterite capped plateau at Panchgani and Mahabaleshwar.(120 km, ~2.30 hrs).

The Panchgani plateau exhibits well-developed ferricrete ("laterite") cap over the Deccan basalts. The NNE-SSW spur at Harrison Folly gives a panoramic view of the high level laterite of Panchgani table land on the southern end and basalt flows exposed along the northwestern hill slopes adjoining the Krishna Reservoir. The extensive Panchgani table land is an excellent location to examine the upper part of the high level *in situ* laterite/ferricrete. Two or more laterite-capped mesas, which have separated from the Panchgani table land by erosion, may be seen. A reconnaissance of the periphery of the

tableland reveals fractures, indicating the beginning of breakaways that result in dislodgement of the huge laterite blocks.

Mahabaleshwar (a popular hill station) is located 20 km west of Panchgani. The Arthur's Seat viewpoint located just before entering Mahabaleshwar town provides a panoramic view of the *Sahayadris*. It is located at the drainage divide and provides a unique opportunity to observe the natural carving on the *Sahyadris*. More than 1-km-thick Deccan lava sequence may be observed from here with the drop from the edge of the plateau to the head of the westerly flowing Savirtri River.

The great escarpment of Western India exhibits similar features as observed in other continental rifted margins which are also associated with flood basalt volcanism. (e.g., The Drakensberg of the Karoo, S. Africa; the Serra Geral escarpment along the eastern edge of Parana, Brazil). These similarities point to a common mode of origin and one of the most likely possibilities is coast-parallel inland scarp recession (Cox, 1988). Scarp recession, the associated erosion, uplift and arching have shaped the Deccan landscape while these processes are still operative.

Lunch at Mahabaleshwar

Return to Pune by 4 – 5 pm.

Depart Pune to Hyderabad by train

BANK ACCOUNT DETAILS

Name of the Account Holder	**:** Dr. R SHANKAR GEOSCIED
Name of the Bank	**:** State Bank of India
Name of the Branch	**:** Mangalagangotri Branch
Branch Code	**:** 8034
IFSC Code	**:** SBIN0008034
Address of the bank	**:** Mangalore University Campus, Mangalagangotri, Karnataka 574199
Account Number	**:** 33963881148
Type of Account	**:** Savings Bank