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Physical Evidence of Vertical and Horizontal Vesicular Cylinders in Imampur Ghat Section in Ahmednagar District

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***Abstract* - Imampur ghat section in Ahmednagar district on Aurangabad – Ahmednagar, Pune highway exhibit physical evidence of vertical as well as horizontal vesicular cylinders. The exposed basalts are found to be massive compact basalt (Pahoehoe) lava flows from elevation of mean sea level (MSL) 605 to the elevation of mean sea level (MSL) 723. There are three vertical vesicular cylinders and three horizontal vesicular zones have been identified. These cylinders vary from 15cm. to 30cm. in width and both have height of 1.5 m. These cylinders are circular to oven shaped in transverse section. The gas migrating channels are vesicular and rarely amygdaloidal in nature. These empty gas cavities have diameter of 0.3 to 0.4 cm. and are having height ranging from 4cm to 7 cm. At few places at top these flow form T junctions. During inflation and solidification, the circular gas – channels might be generated at the lower vesicular crust below, and migrated upwards within the hot, molten core and ultimately accumulated below the visco-elastic crust as a horizontal to sub-horizontal gas channels. These observations at the excavation site indicate a large pahoehoe lava flow.**

***Index Terms* - Vesicular cylinders; compact basalt (pahoehoe) lava flow; lmampar ghat section.**

INTRODUCTION

The end of cretaceous era was marked by catastrophic event which was manifested by volcanic activity which resulted in the form of outpouring of enormous quantity of basaltic lava that covered hundreds of Sq. km. of Western, Central and South India, which is also known as Deccan Trap.

Flowing lava has many dissolved gases and these gases bubble out and tend to move towards shallower level ultimately to the surface of lava. The escaping gas bubbles leave behind the scars or vesicles on the upper surface of the cooling viscous lava flow. Gases streaming out from the base of lava can produce pipe vesicles and subsequently pipe amygdales, if filled by group of low temp. minerals like chalcedony; zeolites. Tracks of two steaming gas bubbles may unite basalt flows during the process of crystallization andvapor differentiated basalt flows, their way up giving rise to pattern called as forked pattern. In contrast, in a study of the Kutsugata lava flow in Japan, Kuritani et al. (2010) propose that the head of the growing vesicular cylinder was fed laterally by flow of residuum from the nearby host lava into the cylinder. Also in contrast to previous studies of other lava flows, Kuritani et al. (2010) conclude that the vesicular cylinders and the vesicular sheets above them in the Kutsugata lava flow are not genetically related.

During the cooling process of lava pipe vesicles are attributed to gas bubbles. These vesicle cylinders are the pipes filled with bubbles and residual melt that differentiate from diktytaxitic basalt flows during the process of crystallization in vapour differentiated basalt flows. They grow 0.25m above the base of flow to the bottom of chilled flow top. During the process of rising of bubble additional vapour and residual melt migrate towards the low pressure area. This may result in contamination of overlying liquid with gas and interstitial melt.(Goff 1960)There are also much rarer vertical cylindrical features in non-inflated basalt lava with vesicularity and chemistry distinct from vesicular cylinders that Kontak and Dostal (2010) term “segregation pipes”; these seem to have a different origin and are not considered here.

To understand the gas transport phenomenon various numerical simulations and investigations based on vesicle size distribution have been carried out.

(Polacci et al.2008) Results from these simulations suggests that the vesicles represents the pathways used by gas to flow non explosively to the surface and indicate development of an efficient system that sustains persistent degassing in basaltic lava system. Due to fast cooling of top and bottom of lava flows quenching of bubbles takes place. However, in hot interior bubbles rise easily and are collected below the crust. During the process of rising of bubbles a nonvesicular core is left behind and at the same time during the process of cooling and crystallization of base new bubbles are formed due to water concentration in the residual melt making the interstitial fluid buoyant. The rise in the residium rich in bubbles through the lava in spaced vertical cylinders results into the formation of vesicular sheets.

STUDY AREA

The area under study lies on Aurangabad - Pune Highway in the ghat section exposed in between 'Pandhricha pool which is situated at the base at the height M.S.L. 605 m. and Imampur village at the top at the height M.S.L. 723 m. The ghat section is 24.300 km.away and is towards North of Ahmednagar town while going towards Aurangabad town.

Table No.1

Name of Ghat Section	Base	Top
Imampur	Lat 190 16'.49 N Long 740 50'.15 E Pandhricha Pool MSL 605m	Lat 190 15'.49 N Long 740 49'.90E Imampur Village MSL 723m

Fig No.2 Map of India

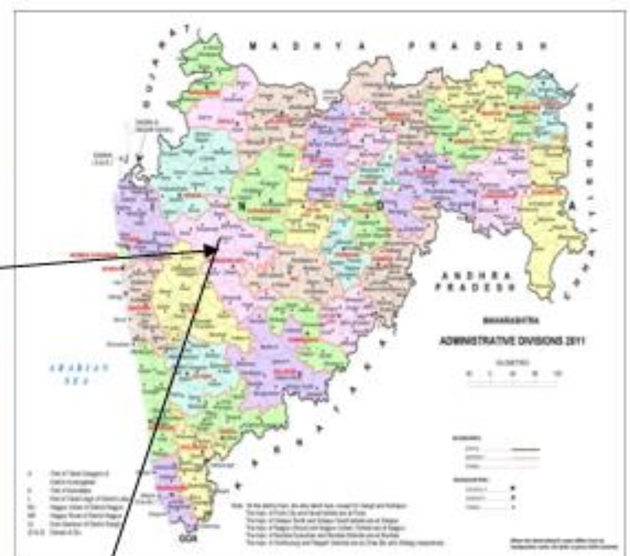

Fig No.2 Map of Maharashtra

Fig No. 3 Location of Study area Imampur in Ahmednagar District

To carry out systematic detailed study of the lava flows the ghat section of Imampur on Ahmednagar-Aurangabad highway at a distance of 24km from Ahmednagar was selected. The ghat section of Imampur ghat has length of 3.5 km with the exposure of 32 lava flows. Though the basalt flows appear to have horizontal surface from a distant view, however, the compact porphyritic basalt flows in Imampur ghat section exhibit lenticular shape with bulbous nature. The phenocrysts of plagioclase in porphyritic flows are visible to naked eyes having length of 2.5 cm to 3 cm. There are two intrusions of amygdaloidal basalt flows having tongue shaped appearance and pipe amygdales having length of 10cm filled with chlorophyte are seen in the Imampur ghat section. The amygdaloidal basalt flows: present in this ghat section is also filled with secondary minerals like calcite; Zeolite, chlorphyte etc.

DESCRIPTION OF THE FLOWS EXPOSED IN THE IMAMPUR GHAT SECTION

Flow No.1: It is exposed at PANDHRICHAPOOL village MSL. 605 m. It is compact porphyritic basalt with medium sized grains of plagioclase seen with naked eyes. Broadly spaced jointing pattern is seen.

Flow No.2: It is a red tachylyte having thickness of 0.5m.

Flow No.3: It is porphyritic basalt flow having lenticular shape with several horizontal quartz veins running parallel to each other.

Flow No.4: It is compact porphyritic basalt flow with plagioclase phenocrysts visible to naked eyes. Well-developed rhombohedral calcite crystals (in vain) are seen in this flow.

Flow No.5: This is amygdaloidal basalt flow with no consistency in jointing pattern. Pipe amygdales of 2.5 cm length are seen.

Flow No.6: It is porphyritic basalt flow having lenticular shape with several horizontal quartz veins running parallel to each other. Lath shaped plagioclase phenocrysts are visible to naked eyes.

Flow No.7: Compact porphyritic basalt flow with lathshaped plagioclase phenocrysts is visible to naked eyes. It has quartz veins running parallel to each other.

Flow No.8: This is thin amygdaloidal basalt flow. Pipe amygdales of 2.5 cm length are seen. Amygdales are filled with secondary minerals like zeolite and calcite.

Flow No.9: It is compact porphyritic basalt flow lenticular in shape. Small sized plagioclase phenocrysts are present.

Flow No.10: This is thin amygdaloidal basalt flow. Amygdales are filled with secondary minerals like zeolite and calcite.

Flow No.11: Compact porphyritic basalt flow with lathshaped plagioclase phenocrysts is visible to naked eyes. Flow has lenticular shape.

Flow No.12: This is compact porphyritic basalt flow having plagioclase phenocrysts of 1 cm length.

Flow No.13: This is thin amygdaloidal basalt flow. Amygdales are filled with chloropheite.

Flow No.14: This is compact porphyritic basalt flow having intrusion of quartz veins in it.

Flow No.15: This is irregular amygdaloidal basalt flow.

Flow No.16: This is compact porphyritic basalt flow with lath shaped plagioclase phenocrysts having size of 3 cm are seen.

Flow No.17: This flow has intrusion of lava having height of 1.5 m and breadth of 12.5 cm at center and it is in the form of lobe. (Fig No.17)

Flow No.18: It is compact porphyritic basalt flow, where plagioclase phenocrysts are visible to naked eyes.

Flow No.19: It is a compact porphyritic basalt flow which is highly weathered along the road cut.

Flow No.20: It is compact porphyritic basalt flow showing spheroidal weathering.

Flow No.21: It is compact porphyritic basalt flow. Well-developed lath shaped plagioclase phenocrysts are visible to naked eyes.

Flow No.22: It is a red tachylyte having thickness of 0.5m. Demarcating the contact between flow no.21 and flow no.23.

Flow No.23: It is compact porphyritic basalt flow in which well-developed lath shaped plagioclase phenocrysts of 3 cm length are visible to naked eyes.

Flow No.24: It is a thin amygdaloidal basalt flow. Amygdales are filled with chlorophyte.

Flow No.25: It is a compact aphanitic basalt flow. Spheroidal weathering is seen along the roadside.

Flow No.26: This is an intrusion of amygdaloidal basalt flow. The intrusion has width of 30cm. and height of 1.5 meters. At its center and contact margins it exhibits brown colour. Well-developed pipe amygdales filled with chlorophytic content with size upto 7 cm. are clearly seen lateral extent of the intrusion is of 2.5 meter. (fig no.6)

Flow No.27: This is flow of Amygdaloidal basalt and has an intrusion of Amygdaloidal basalt flow. The intrusion has intruded from its base and has height of 1.5 meters. Its width is of 15 cm at centre. The intrusion at its top has lateral extent of 2.5 meters on both the sides (lateral) and exhibits umbrella like appearance. (fig no.7)

Flow No.28: This is compact aphanitic basalt flow. Due to weathering it appears to green in colour.

Flow No.29: It is a red tachylyte having thickness of 0.5m. demarcating the contact between flow no.28 and flow no.30.

Flow No.30: This is a compact aphanitic basalt flow having lenticular shape. Vesicles are seen at its top portion.

Flow No.31: It is a red tachylyte having thickness of 0.5m.

Flow No.32: It is a compact aphanitic basalt flow present at the topmost portion of the Imampur ghat section.

Summary of the salient features of this ghat section is given below in Table No.2

Table No.2

Description of lava Flows	Imampur Ghat
Thickness of lava pile	118m
Minimum elevation above MSL	605m
Maximum elevation above MSL	723m
No. of flows	32
Minimum and maximum thickness of flows	1m to 30m
No. of Amygdaloidal flows	9
No. of compact porphyritic basalt flows.	15
No. of compact aphanitic basalt flow	4
No. of Red bole beds	4

Based on the thickness of compact aphanitic and porphyritic basalt lava flows in both the ghat sections the flows can be divided into four groups.

1. Very thin flows having thickness ranging from 1 cm to 5 meters.
2. Thin flows having thickness ranging from 6 meters to 15 meters.
3. Moderately thick flows having thickness ranging from 16 meters to 30 meters.
4. Very thick flows having thickness more than 30 meters.

Based on above groups in Imampur ghat section out of 15 compact porphyritic basalt flows 7 flows are very thin flows ranging from 1 meter to 5 meters.

6 flows of porphyritic basalt are thin ranging from 6 meters to 14 meters.

There are 2 very thick flows having thickness of 30 meter and 40 meters respectively.

Out of four flows of compact aphanitic basalt three flows in Imampur ghat section are thin having thickness ranging from 2 meters to 4 meters and 1 flow has thickness of 12 meters.

Above data indicates that compact porphyritic basalt flows are predominant in Imampur ghat section

There are 15 flows of compact porphyritic basalt making 64.83% of the entire ghat section with average thickness of 5.10 m. few of these have lenticular shape. There are four flows of compact Aphanitic basalt making 12.28% of the entire ghat section with average thickness of 3.62m. There are four flows of Red Tachylyte with average thickness of 0.5 m. making 1.70% of the ghat section.

Table No.3 Flow Type, Thickness and their percentage in Imampur Ghat Section

Flow Type	Total No. of Flows	Maximum thickness in Meter	Minimum Thickness in Meter	Average Thickness in Meter	% of Flow type in Entire Ghat Section.
Amygdaloidal Basalt	9	3 Meter	0.5 Meter	2.72Meter	20.75%
Compact Aphanitic Basalt	4	6 Meter	2 Meter	3.62 Meter	12.28%
Red Tachylyte	4	0.5 Meter	0.5 Meter	0.5 Meter	1.70 %
Compact porphyritic Basalt	15	40 Meter	1 Meter	5.10 Meter	64.83%

OBSERVATIONS

There are three flows of Amygdaloidal basalt with clear exposure of lava tubes / tunnels. They are in flow no 17 (MSL 686.5 m, Fig. No.5); flow No. 26 (M.S.L.

697.5m, Fig. No.6) and flow no 27 (M.S.L. 697.5 m, Fig No.7) respectively. Whereas flow no.5 and flow No. 8 are spread horizontally. In flow no. 26 the vertical cylinders are found tobe circular to oval shape. The lava intrusion has width of 30cm at centre, however, at its top it has spread and has lateral extent of 2.5 cm. and exhibit Umbrella like appearance. At the centre and at contact margins it exhibits brown colour. These pipe amygdales have length of 7 cm., and the diameter is 0.3 cm. The empty gas cylinders / cavities are circular to oval in outline. The occurrence of brown colour at the contact margins is clearly an indication of baking and welding due to heating.

The reddened rock underlying the floor of a channel is of great help in recognizing the presence of channel at places where their upper parts have been. The transverse section of horizontal vesicular zone exhibits randomly oriented horizontal gas migrating channels. Most of the vertical gas channels have migrated upward and ceased within centre of lava flows.

PETROGRAPHY

Plagioclase phenocrysts are visible in thin sections of Imampur ghat section. Augite, set in groundmass of plagioclase clinopyroxene; olivine; opaques and glass are also seen. The plagioclase microphenocryst size ranges from 7.5 mm to 13 mm whereas megaphenocryst ranges from 26mm to 40mm in the flows of Imampur ghat section. The phenocrysts occur singly and also in glomeroporphyritic aggregates, dominated by plagioclase. Ophitic and sub ophitic relationship between plagioclase and augite is observed both in phenocryst and groundmass phases. Intersertal and intergranular texture is also observed. Few flows exhibit excellent orientation marked by parallel arrangement of plagioclase laths.

The anorthite content in plagioclase laths of Imampur ghat section is 45% in all flows. Laths of plagioclase with corroded border are seen in few flows. Plagioclase laths are exhibiting polysynthetic twinning, Carlsbad twinning and albite twinning. Normal zoning in few plagioclase laths is also seen in flows of this ghat section.

Augite phenocryst occurs as colorless to pale brown subhederal to platy crystals. Rarely olivine phenocryst occur as euhedral to subhedral grains in some flows augite and olivine is altered into chlorite. The groundmass comprises elongated laths and microlites of plagioclase, granular augite, opaques and glass. Opaques occur in varying proportions as anhedral to subhedral, skeletal and dendritic grains. In some flows they attain phenocrystic dimensions with inclusions of plagioclase, and augite. Glass occurs in all flows. Surprisingly, spherulitic texture is exhibited by some lava flows of Imampur ghat section. These spherulites occur in clusters or groups. when viewed under microscope these spherulites exhibit perfect black extinction cross which remain constant when the stage is rotated through 3600. This structure is very rarely reported in Deccan basaltic lava. These spherulites show radiating growth of feldspar and trydamite fibers.

Thin sections when are prepared of the gas cylinders more than 90% are empty (Fig. No. 8) some gas cylinders at peripheral parts are lined by greenish palagonite (cholorphite) (fig No.11) which is an indication of devitrification of glass. Some cylinders are filled by secondary minerals like quartz and zeolites. In thin section the rock appears glassy. In some thin section fine grained groundmass of plagioclase is also seen. In few thin sections intergranular (Fig. No.9) andintersertal textures (Fig. No.10) are also seen. (Deshmukh 1988; Sarkar and Upasani 2016).

CONCLUSION

The size and direction of vesicles and empty gas cylinders / amygdales are indicative of the pathways used by the gases to escape. The gases present in the lava tube (in a lava system) may get entrapped and may not escape it entombed by younger lava flow. Due to the exerted pressure of the young lava flow the margin of the earlier / former flow may get ruptured may result into the formation of new channel ways. Inability of the entrapped gases to escape may have resulted into the formation of lateral offshoots, due to diversion of gas pressure in lateral direction. The circular gas – channel ways may have been formed during the process of solidification of lava. The occurrence of few lenticular shaped porphyritic basalt flows in this ghat section may indicate the outpouring of lava in small quantity. The predominance of lath shaped and large sized Plagioclase phenocrysts in the lava flows of Imampur ghat section may indicate the accumulation of plagioclase phenocrysts by floatation in highly differentiated magma that concentrated near the roof of magma chamber at shallow depth. The field characters of basalt flows of the ghat sections of study area have clean basalt to basalt contact at many places which confirms the view that the lava flows came in quick succession and there were no intertrappean intervals as concluded by Kulkarni,(1975).Presence of Red Tachylytic basalt without backed soil or tuffs in the Imampur ghat section is in agreement with the conclusion drawn by Kulkarni(1975) that the lava flows came in quick succession without Intertrappean intervals.The intrusion of lava flow in flow no.17,26 and 27 may indicate the presence of a common conduit or inter connectivity of lava tubes below the surface.

REFERENCE

[1] Agashe I. V, Gupte R. B (1968) Some Significant featuies of Deccan trap Mem. eol. Society of India Vol. –II, P.P. 309 to 319

[2] Al mukhamedov, A. I. and Zolotukhin V. V. 1988 Geochemistry of Low potassic Basalts from Siberia and Deccan Traps mem.Geol. Soc. India No. 10 PP. 341-351.

[3] Choube V. D. (1973) Long distance correlation of Deccan trap Basalt flows of central India, Bull Geol. Society V.84, P. P. 2785-2790

[4] Cox. K. G. and Hawkesworth C. J. (1984), Geochewical Stratigraphy of Deccan Trap of Mahabaleshwar, Western Ghats, India with implication for open system magmatic process, Journ, Petrology V 26. P. P. 355-377

[5] Deshmukh S.S. (1988), Petrographic variations in compound flows of Deccan Trap and their signiticance. Geol. Soc. India Mem 10, P. P. 305 to 320.

[6] Devey C. W. (1986) Stratigraphy and Geochewistry of Deecan Trap Lavas Western India Ph. D. Thesis University of oxford U. K. 3569.

[7] Godbole S. M. Chatterjee A. K. (1996) Note on Geochemistry of sub – surface lava pile at Nazardeo, Jalgam Dist. Maharashtra, Gondwana Geol, Magzine Spl. Volume 2 PP. 81-88.

[8] Godbole S. M. Rana R. S. and Natu S. R. (1996) Lava Stratigraphy of Deccan Basalts of western Maharashtra Gondwana Geol. Magzine Spl. Vol. 2, pp. 125-134.

[9] Goff. F. (1996) Vesicle cylinders in Vapour, differentiated basalt flows. Journ. Volcanol. Geothermal Res. V. 71 PP. 167-185.

[10] Hooper P. R., Subbarao K. V. and Beane J. E. (1988), The Giant Phenocryst Plagioclase Basalt (GPBS) of Western Ghats, Deccan Trap, Geological Society India, Mum, 10 P. P. 135-144.

[11] Jyotisankar Ray and Mihir K. Bose Problem of Deccan Basalt Magula Type and crustal contamination: A Geochemical Review. Geol. Magazine Spl. Vol. 2 PP. 293-299.

[12] Konda T. (1985) Regional Petrology of Deccan volcanic Province, Sukeswala Vol. Indian Mineralogist pp. 75-91.

[13] Kontak, D.J. and Dostal, J., The late stage cystallization history of the Jurassic North Mountain Basalt, Nova Scotia, Canada. II. Nature and origin of segregation pipes. Canad. Mineral. 2010, 48, 1533–1568.

[14] Krishnan M. S. 1982 Geology of India and Burma CBS publication & Dist. New Delhi P. 536.

[15] Kuritani, T., Yoshida, T. and Nagahashi, Y., Internal differentiation of Kutsugata lava flow from Rishiri Volcano, Japan: Processes and timescales of segregation structures' formation flows. J. Volcanol. Geotherm. Res. 2010, 195, 57–68.

[16] R. K. Sharma and Sudha Vaddadi (1996) Report on Lava Tubes / Channels from Deccan Volcanic Province, Pune and Ahmadnagar, Districts Maharashtra, Gondwana Geological Magzine, Spl. Vol. 2, PP. 457-460.

[17] Sarkar P. K. (2007) A rare circular, pipe shaped structure in Deccan Trap Lava flows in Girna River Section near Malegaon Dist. Nasik curr. Science V. 93 PP. 915-916.

[18] Sarkar P. K. D. Y. Upasni et. Al. (2016) Physical Evidence of Vesicular cylinders in pahoehoe Lava Flows at Pataleshwar Temple – Pune – India Journal of Geosciences Research vol. 1 PP. 11-15.

[19] T. Sano and T. Fujii (1996) Chemical variation of Uncontaminated (Ambenali like) basalts of Deccan Traps. Geol. Magzine SP. Vol. 2. Pp. 301, 309.

[20] Thorat P. K. (1996) Occurrence of Lava Channels and Tubes in the Western part of Deccan Volcanic Province Geological Magazine Sp. Vol. 2 pp. 449 -456.

[21] Walker G P L 1999 Some observations and interpretations on the Deccan Traps; In: Deccan Volcanic Province, (ed) K V Subbarao, Mem. Geol. Soc India 43 367–395

[22] Watson E B 1982 Basalt contamination by continental crust: some experiments and models; Contrib. Mineral. Petrol. 80 73–87

[23] Watts A B and Cox K G 1989 The Deccan Traps: an interpretation in terms of progressive flexure in response to a migrating load; Earth Planet. Sci. Lett. 93 85–97

[24] West W D 1958 The petrography and petrogenesis of fortyeight flows of Deccan Traps penetrated by borings in western India; Trans. Nat. Inst. Sci. India 4 1–56.

[25] West W D 1981 The duration of Deccan Trap volcanicity; Mem. Geol. Soc. India 3 277–278

[26] White R S and McKenzie D 1995 Mantle plumes and flood basalts; J. Geophys. Res. 100 17543–17585

[27] Widdowson M and Mitchell C 1999 Large-scale stratigraphical, structural, and geomorphological constraints for earthquakes in the southern Deccan Traps, India: the case for denudationally-driven seismicity; Mem. Geol. Soc. India 43 425–452

[28] Wilkins A, Subbarao K V, Ingram G and Walsh J N 1994 Weathering regimes within Deccan basalts. In: Volcanism, (ed) K V Subbarao, (New Delhi: Wiley Eastern) 217–231

[29] Wilson M 1989 Igneous Petrogenesis, (London: Unwin Hyman).

FIGURES

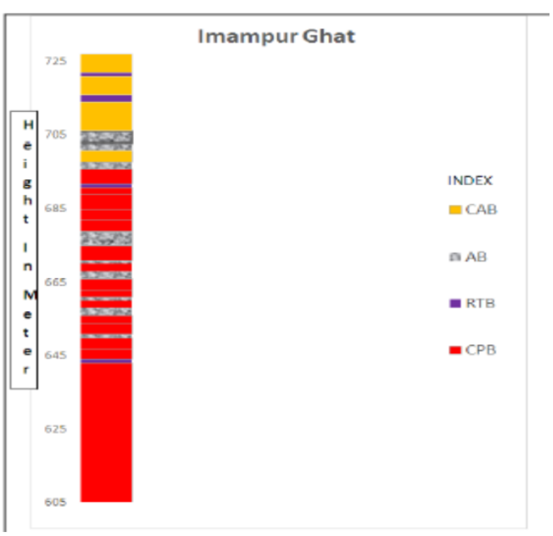

Fig. No. 04: L-Section of Lava Flows in Imampur Ghat

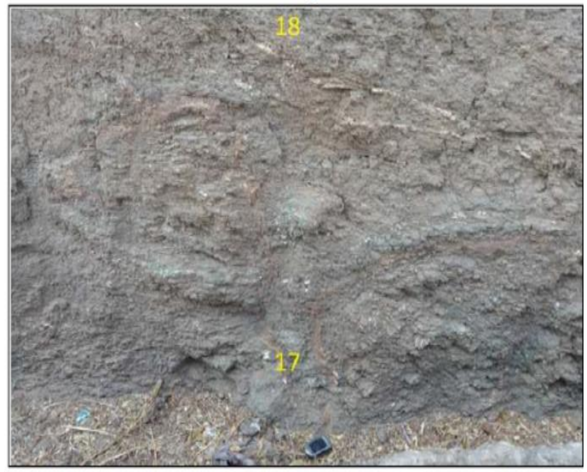

Fig No. 5 Intrusion of lava in flow no. 17

Fig No. 6An Intrusion of lava in Flow no. 26

Fig No. 7An Intrusion having umbrella shape in Flow no. 27

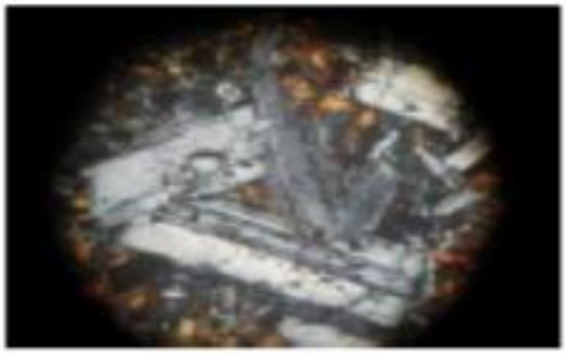

Fig. No. 8: Thin Section of Flo. No. 26 Showing empty Gas cylinder Crossed Nicols 10X

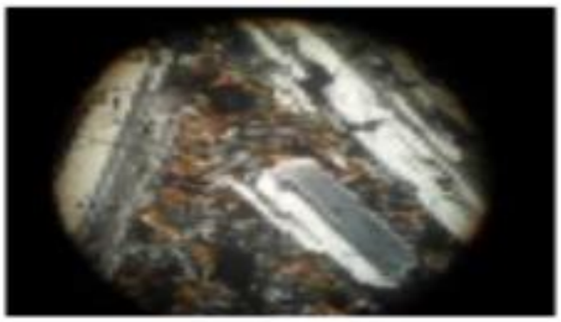

Fig. No. 9: Intergranular Texture Crossed Nicols 10X

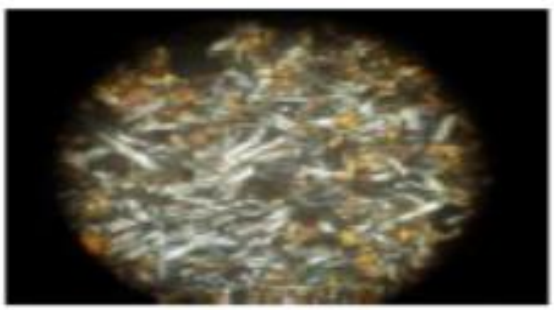

Fig. No.10: Intersertal Texture Crossed Nicols 10X

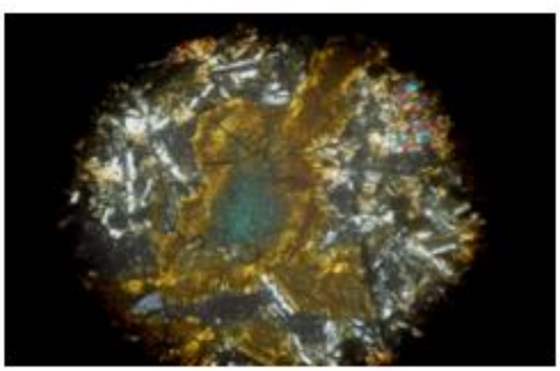

Fig. No. 11: Cross section of pipe amygdale filled with Chlorpheite