

## Project Proposal Form – 2022 entry

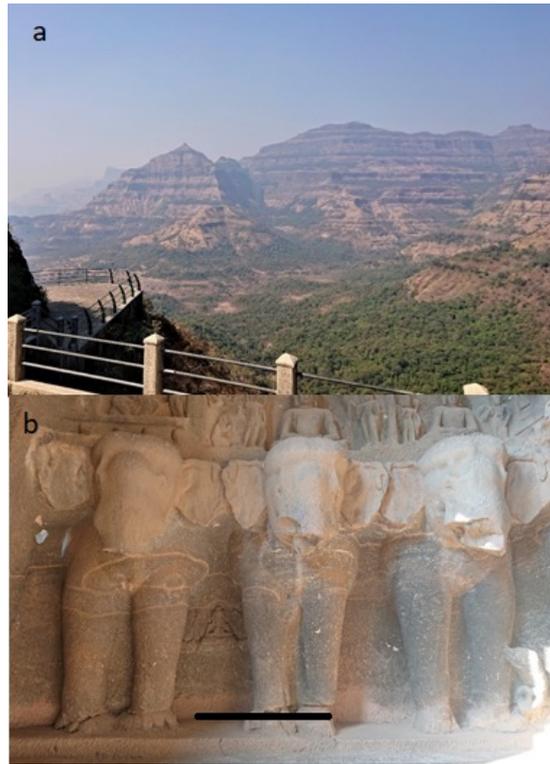
<b>Project Title</b>	<b>OU6 - Rapid emplacement of the lower Deccan Traps and its implication for late Cretaceous climate change</b>
<b>University (where student will register)</b>	The Open University
<b>Which institution will the student be based at?</b>	As above
<b>If other</b>	
<b>Theme (Max. 2 selections)</b>	Climate & Environmental Sustainability <input type="checkbox"/> Organisms & Ecosystems <input type="checkbox"/> Dynamic Earth <input checked="" type="checkbox"/>
<b>Key words</b>	Large igneous province, basalt, volcanology, geochemistry, Deccan, India, climate, field work
<b>Supervisory team (including institution &amp; email address)</b>	<b>PI:</b> Dr Anne Jay, Open University, <a href="mailto:anne.jay@open.ac.uk">anne.jay@open.ac.uk</a>  <b>Co-I:</b> Dr Frances Jenner, Open University, <a href="mailto:frances.jenner@open.ac.uk">frances.jenner@open.ac.uk</a> Dr Simon Passey, CASP, <a href="mailto:simon.passey@casp.org.uk">simon.passey@casp.org.uk</a>
<b>Is the project co-designed by a student?</b>	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
<b>Is the PhD suitable for part time study?</b>	Yes <input checked="" type="checkbox"/> This is a requirement of NERC

### Project Highlights:

- Two field seasons in Deccan Traps, India logging and studying basaltic pahoehoe flows, their volcanic features and collecting samples
- Study the volcanic stratigraphy and flow relationships to develop a method using GIS and photogrammetry, to assess the emplacement durations of basaltic flows in large igneous provinces.
- Geochemical analysis of collected basaltic samples to aid stratigraphic correlations as well as quantifying their compositions and gas content for assessment of environmental impacts.

### Overview:

The Deccan Large Igneous Province (LIP) is associated with the Cretaceous-Paleogene Boundary (KPB) mass extinction event at 66Ma. However, this is not the only environmental crisis it is linked to. *Petersen et al. 2016* show a regional warming and extinction event in Antarctica and *Hull et al. 2020* constrain an implied major volcanic outgassing event. Both are ~250,000 years before the KPB. Such events suggest a sustained period of large volume volcanic activity. The Thakurvadi Formation in the Kalsubai Sub-group, Deccan, is a prime candidate for this.



*Figure 1a: View north along the Western Ghats escarpment, Deccan LIP, India. The entire cliff face is Thakurvadi formation. Figure 1b, Pāhoehoe lobes picked out in temple carvings, note how the elephant's trunks have detached along a flow boundary, scale bar is ~1m.*

*Alt text: Fig 1a, incised cliff face approximately 1 km high, formed of multiple flat lying lava flows. The valleys are forested. Fig 1b, 2.5 m high elephants carved into pahoehoe basalt rock within a Hindu temple. Their trunks have all fallen off at mouth level along a lava flow boundary.*

The Thakurvadi Fm (Fig. 1a, b) is up to 600m thick and covers ~80,000km<sup>2</sup>, although its full extent is not known. The flows of the Thakurvadi form a thick, competent part of the Western Ghats Escarpment (WGE; Fig. 1a), with very few weathering horizons. This and the welded appearance of the lobes indicate rapid emplacement with little pause between eruptions. The continuous emission of gasses could have caused the environmental effect ~250,000 years before the KPB.

## Methodology

The first field season will involve logging, photogrammetry and mapping of the Thakurvadi in the WGE to recreate 3D volcanic architecture and volcanostratigraphy of the welded lobes and establish their size and spatial relationships. Samples will be collected and analysed using the electron microprobe. SIMS analyses of hosted melt inclusions will enable their sulfur, chlorine, fluorine, carbon and water concentrations to be quantified.

The second field season will establish whether the style of the Thakurvadi continues further east and will help confirm its association with the pre-KPB environmental perturbation. Geochemical analyses (electron microprobe, XRF and ICP-MS), particularly incompatible trace elements, will be used to confirm the presence of Thakurvadi flows by comparing their chemistry with the known chemostratigraphy. Identification and interpolation of formation boundaries will help constrain the Thakurvadi Formation volume.

Basic modelling will be undertaken to link new gas emissions data to perturbations seen 250,000 years before the KP. B.

### **Training and skills:**

Students will be awarded CEN2 Training Credits (CTCs) for participation in CEN2-provided and 'free choice' external training. One CTC equates to 1/2 day session and students must accrue 100 CTCs across the three years of their PhD.

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Training will be given in:

- Logging basaltic lava flows.
- Basic surveying techniques.
- Using GIS software for spatial modelling
- Using photogrammetry and creating 3D images
- Geochemical analytical techniques and data handling skills.
- Planning and running a successful field trip.
- The successful candidate will be encouraged to attend relevant conferences. They will also be supported in applying for a placement, and to take part in career-enhancing opportunities such as teaching, science communication and understanding policy.

### **Partners and collaboration:**

The project will collaborate with *Prof. Stephen Self* (University of Berkeley, California) a world leading expert in the emplacement of LIPs, who will be present for at least part of the field trips. To provide expertise in India: *Dr Gauri Dole* (Savitribai Phule Pune University), *Dr Vivek Kale* at (Advanced Center for Water Resources Development and Management, Pune; India), both Deccan volcanostratigraphical experts and *Dr Makarand Bodas* the Deccan LIP lead at the Geological Survey of India. A placement at CASP is available and, Covid-dependent, the possibility of a field trip to Ethiopia as field assistant to co-supervisor Dr Simon Passey.

### **COVID-19 Resilience of the Project:**

If Covid-19 prevents overseas fieldwork the project could study the geochemical evolution of the Thakurvadi Formation by analysing pre-existing geochemical data, new geochemical and petrographically data from existing rock samples. Or a GIS could be built to analyse pre-existing data of the Deccan. If UK field work is possible, the project could focus on the physical volcanology of the extrusives of the North Atlantic Igneous Province as a comparison with the Deccan, possibly using drones to create 3D data sets. We will work with the successful applicant to build a project that interests them.

**Possible timeline:**

Year 1: Literature review on the Deccan Traps and Thakurvadi Fm in particular. Collate information on its current extent and exposure. First field trip to India in January/February including detailed fieldwork training with supervisors. Analyse data from fieldwork using GIS. Start analyses on glass inclusions.

Year 2: Second Field trip to India. Attend VMSG conference. Analyse data from fieldwork including geochemistry, and write up manuscript on Emplacement of Thakurvadi Fm. Use GIS to estimate volume of the Thakurvadi Fm.

Year 3: Finish interpretation, assess impact of Thakurvadi Fm on Pre-KPB environment, prepare thesis and further manuscripts. Presentation at an international conference. Possibly suspend PhD studies for several months to complete internship.

**Further reading:**

Hull, P. M., Bornemann, A., Penman, D. E., Henehan, M. J., Norris, R. D., Wilson, P. A., Blum, P., Alegret, L., Batenburg, S. J., Bown, P. R., Bralower, T. J., Cournede, C., Deutsch, A., Donner, B., Friedrich, O., Jehle, S., Kim, H., Kroon, D., Lippert, P. C., ... Zachos, J. C. (2020). On impact and volcanism across the Cretaceous-Paleogene boundary. *Science*, 367(6475), 266–272.  
<https://doi.org/10.1126/science.aay5055>

Jay, A. E., Mac Niocaill, C., Widdowson, M., Self, S., & Turner, W. (2009). New palaeomagnetic data from the Mahabaleshwar Plateau, Deccan Flood Basalt Province, India: implications for the volcanostratigraphic architecture of continental flood basalt provinces. *Journal of the Geological Society*, 166, 13–24. <https://doi.org/10.1144/0016-76492007-150>

Jay, A. E., Marsh, J. S., Fluteau, F., & Courtillot, V. (2018). Emplacement of inflated Pāhoehoe flows in the Naude's Nek Pass, Lesotho remnant, Karoo continental flood basalt province: use of flow-lobe tumuli in understanding flood basalt emplacement. *Bulletin of Volcanology*, 80(2).  
<https://doi.org/10.1007/s00445-017-1189-6>

Kale, V. S., Dole, G., Shandilya, P., & Pande, K. (2019). Stratigraphy and correlations in Deccan Volcanic Province, India: Quo vadis? *Geological Society of America Bulletin*.

Petersen, S. V., Dutton, A., & Lohmann, K. C. (2016). End-Cretaceous extinction in Antarctica linked to both Deccan volcanism and meteorite impact via climate change. *Nature Communications*, 7, 9.  
<https://doi.org/10.1038/ncomms12079>

**Further details:**

Applicants should have a strong background in, and enthusiasm for, field geology. An interest in volcanology, detailed logging of stratigraphically sequences (any logging, volcanological is not necessary) and knowledge of GIS software (e.g. QGIS, ArcPro, ArcMap) would be advantageous.

The successful student will join a well-established team researching Dynamic Earth processes at the Open University ([http://www.open.ac.uk/science/environment-earth-ecosystems/research/dynamic\\_earth](http://www.open.ac.uk/science/environment-earth-ecosystems/research/dynamic_earth))

Please contact **Dr Anne Jay** ([anne.jay@open.ac.uk](mailto:anne.jay@open.ac.uk)) for further information.

Applications should include:

- an academic CV containing contact details of three academic references
- a CENTA application form, downloadable from: [CENTA application](#)
- and an Open University application form, downloadable from: [Home OU application form](#) (if you are resident in the UK) or an [Overseas OU application form](#) (if you are an international applicant).

Applications must be sent to [STEM-EEES-PHD@open.ac.uk](mailto:STEM-EEES-PHD@open.ac.uk) by **Friday 7<sup>th</sup> January 2022 (12 pm, noon)**