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INSELBERGS IN VIJAYAN COMPLEX OF SRI LANKA

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Outline of the Presentation

- Introduction
- Previous Studies
- Research objective
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- Results and Discussions
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Introduction

Inselberg, (from German Insel, “island,” and Berg, “mountain”), is an isolated hill that stands above well-developed plains and appears not unlike an island rising from the sea. The early German explorers of southern Africa were impressed by such features, and they dubbed the domed or castle-like highlands inselbergs.

There are no books, articles, or detailed research on “Inselberg”, few geographers and geologists have mentioned only the word ‘Inselberg’ with a very short description. However, detailed research emphasizing geology, geomorphology, zoology, botany, agriculture, vegetation, microbiology, etc. has been undertaken in Australia, southwestern Africa, and many European countries.



Figure 1: Pilot Mountain, North Carolina.



Pilot Mountain, North Carolina



 **Britannica**



Inselberg and associated economic activities, Pilot Mountain, North Carolina.

Encyclopedia Britannica



Formation of an Inselberg

An inselberg is one of the landforms resulting from erosional processes.

Inselbergs arise from rocks which erode at a slower rate than that of the surrounding rocks.

The landform consists of **an erosion-resistant rock** which protects a softer rock such as limestone. The resistant rock remains isolated as ongoing erosion erodes the less resistant rock around it.

Volcanic processes are responsible for the rising of the resistant rock above the surrounding area. The resistant rock is able to resist erosion due to its tight joints. Once formed, inselbergs appear steep-sided.

Over time, inselbergs may be destroyed through the marginal collapse of exfoliation sheets and joint blocks.

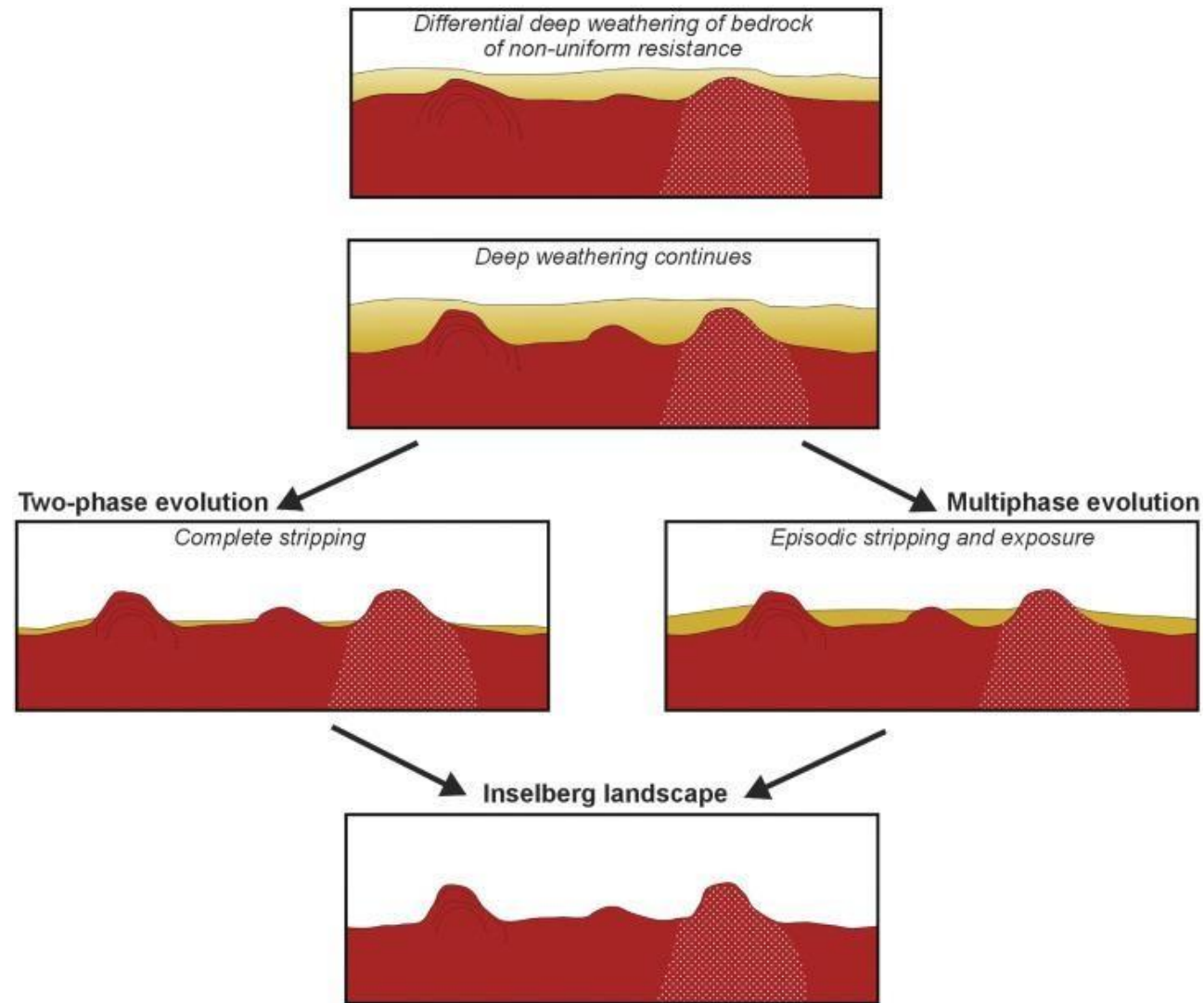
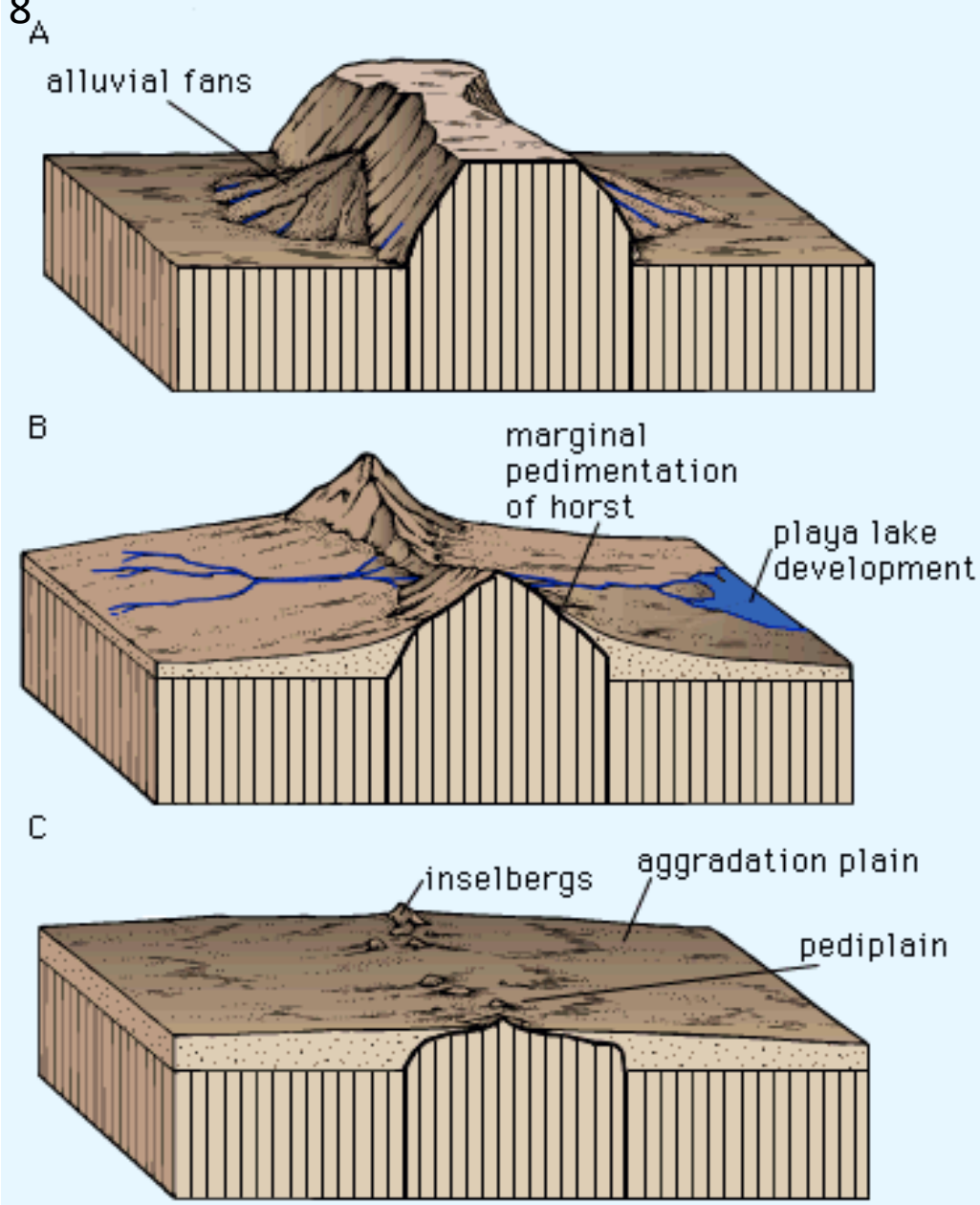


Figure 2: Model of Inselberg evolution through etching and stripping. Reasons for the location of particular inselbergs may be lithological (right) or structural (left).



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Figure 3:

Three-phase block diagram of sedimentation of an upland in a desert.

The process of scarp retreat and planation is accomplished by sheet washing on non-vegetated surfaces. Still, it cannot begin until a **local base level** of erosion-deposition is established.

Streams dissecting the upland cannot cut below the level created where deposition of alluvium begins as runoff dissipates.

The long-term locus of that deposition established the datum for lateral stream-bank and valley-wall recession at higher elevations.



Previous Studies

TROPICAL BIOLOGY AND CONSERVATION MANAGEMENT - Vol. IV - *Inselbergs: Vegetation, Diversity and Ecology* -
Manfred Kluge, Burkhard Büdel

INSELBERGS: VEGETATION, DIVERSITY AND ECOLOGY

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Keywords: Algae, climatic factors, Crassulacean Acid Metabolism (CAM), cryptogams, cyanobacteria, desiccation tolerance, drought, ecological adaptation, edaphic factors, geomorphology, homoiohydric plants, inselbergs, inselberg genesis, inselberg habitats, inselberg typology, inselberg vegetation, lichens, mineral nutrients, poikilohydric plants, stress avoidance, stress tolerance, vascular plants.

FLORA OF THE INSELBERGS MAFA-MAFOU AND BRAFOUEBY AND THEIR PIEDMONTS (SOUTH-EASTERN OF CÔTE D'IVOIRE)

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ABSTRACT

This study relates to the characterization of the flora of two inselbergs (Brafouéby and Mafa-Mafou) located at Sikensi and Adzopé, in forest zone of Côte d'Ivoire. The inventories floristic carried out made it possible to draw up a floristic list made up of 389 species, 290 genus and 88 families. The importance of the families on the inselbergs depends on the surrounding matrix. The study of the biological spectra revealed the clear predominance of the phanérophytes of which the density believes the top downwards. The analysis of the phytogeographical spectra highlighted abundance and the predominance of the bases element of guineo-congolaise. The proportions of the species with broad distribution and those of connection decrease of the top downwards. In addition, the number of species guineo-congolaises believes of the top downwards.

Key Words: Inselberg, Brafouéby, Mafa-Mafou, Forest Zone and Flora



PHYTOGEOGRAPHY AND VEGETATION OF TROPICAL INSELBERGS

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Abstract: A short survey of the vegetation of neo- and paleo-tropical rock outcrops (inselbergs) is provided. The data are based on field studies in West Africa (Ivory Coast, Guinea, Cameroon), East Africa (Malawi), Madagascar, Brazil, Venezuela and French Guyana. The insular rock habitats are covered by a highly adapted flora differing almost totally from the surrounding vegetation and thus provide models for studying questions of island ecology.

Apparently nude rock surfaces are usually covered almost completely by cyanobacteria (e.g. French Guyana) or lichens (e.g. Ivory Coast). The fragmented angiosperm vegetation consists of a mosaic of different vegetation types. Characteristic are monocotyledonous mats (Bromeliaceae in the neotropics and Cyperaceae in the paleotropics), flush vegetation (many *Utricularia* spp., *Genlisea* spp., *Burmannia* spp., Eriocaulaceae) and seasonal plant communities in rock pools (e.g. Scropholariaceae). Phenotypic similar life forms occur convergently in the paleo- and neotropics (e.g. caulescent rosette-trees in Cyperaceae, Velloziaceae).

Keywords: Biodiversity, geobotany, inselbergs, island ecology, phytogeography, rock outcrops. Bromeliaceae, Cactaceae, Velloziaceae.



Diversity of vegetation types of the Pidurangala Granitic Inselberg, near Sigiriya, Sri Lanka: a Preliminary Study

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ABSTRACT

A short field survey was carried out from July to October 2014 at Pidurangala Granitic Inselberg (7°57'58"N, 80°45'43"E) to check plant diversity of the area. Using Lines Transect Method, 92 species belongs to 54 families were identified from this area, which are highly related variations in the rock slope, soil depth and the distribution of seasonal rainfall. Among the species on the rock surface, some are endemic to the xeric scrubland, which consists primarily Euphorbia antiquorum and Euphorbia tirucalli and others others are restricted to slope areas. This paper is the first preliminary study of shrubby thickets (species) on Pidurangala inselberg. As most of these local floras are being used for different purposes including medicinal usage, conservation of such granite inselbergs vegetation is essential.

Key word: Diversity, vegetation types, Granitic Inselberg, climatic conditions, xeric shrub land

Utility of Inselbergs and Boulders as Rock-Shelter Monasteries: A Geoarchaeological Study of Sigiriya and Its Environs

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Abstract

Inselbergs and other rock outcrops such as erratic boulders, granitic tors and corestones formed natural rock-shelters, and are important in archaeological studies. These rock-shelters extensively used to prevent weather afflictions, and later converted as living places by prehistoric man and the members of different faiths in the historical period. They left behind debris, tools and other artifacts, which mark the footsteps of the civilization of humankind. By 5,000 yr BP civilized *Yakka*, *Naga* and *Deva* natives who lived as natives in Sri Lanka have built separate sequestered settlements, and used rock shelters. Large numbers of such natural rock shelters are found in Sigiriya and its environs. The natives, who used these rock shelters consecrated them to Buddhist monks. These were widely used as monasteries during the Early Anuradhapura Period, especially between 2,300 yr BP and 1,800 yr BP. Field observations of seven locations in the area reveal that the architects selected big holes and fractures of the main rock outcrops or a shelter of a single boulder or clusters of boulders to construct comfortable monasteries. These age-old monasteries have geoarchaeological values, which reveal our buried cultures.

Keywords

Rock-Shelters, Sigiriya and Its Environs, Natives, Buddhist Monasteries, Early Anuradhapura Period, Geoarchaeology



Tropical rock outcrops (inselbergs): their importance as habitat islands

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- Environmental conditions
- Plant communities on inselbergs
- Adaptive strategies





Famous Inselbergs

The Spitzkoppe inselberg, rising to 3,600 feet in the Namib Desert, is the tallest of this landform in Africa.

Rising to 2,625 feet are the Sandstone Inselbergs, which characterize the landscape in southwest Jordan.

Stone Mountain in the US state of Georgia is a *monadnock* rising to 785 feet.

Another famous inselberg is Uluru/Ayer's Rock, a non-granitic inselberg located in Central Australia.

There exist inselbergs which have been transformed by ice sheets in the northern region of Sweden.



Importance of Inselbergs

The isolation of inselbergs promotes the development of micro-climatological conditions on the landforms.

Micro-climatological conditions provide a fertile ground for the growth of unique flora that is adapted to the particular ecological environment.

Some inselbergs have been declared as ***floral hotspots*** due to the set of vegetation present in them.

Vegetation often remains undisturbed since the Inselbergs do not support agriculture and are thus spared of human activities.



Inselbergs of Sri Lanka

Inselbergs of Sri Lanka have stood out against the leveling process of nature largely because they are made of resistant granitic rocks containing large proportions of quartz, one of the most indestructible of rock-forming minerals (Cooray, 1984).

In Sri Lanka, bare rock mounds or turtle-back-shaped inselbergs are scattered in the Second & Third Planation Surfaces (Katupotha 2013).

In Sri Lanka, it is possible to recognize that nearly 2,000 or more inselberg structures can be identified from Dry Zone, Intermediate Zone, and Wet Zone, and these are widely distributed in above third planation surfaces.



The relief of this Planation Surface consists of Flat terrain to Undulating terrain, Rolling, and Hilly terrain.

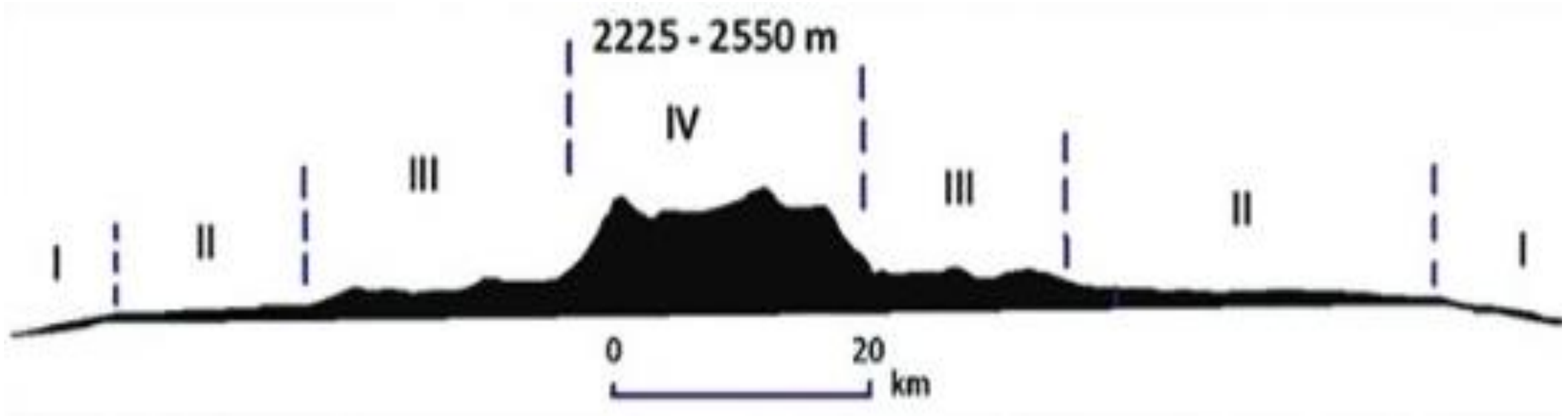


Figure 5: Diagrammatic section across Sri Lanka from west to east showing the four planation surfaces. I – first submerged), II– second (Flat terrain to Undulating terrain, Rolling and Hilly Terrains, III - third (Dissected Rolling and Hilly; Steeply Dissected Rolling and Hilly Terrains, and IV - fourth (Mountainous and Rugged Central Highland) Katupotha /Journal of Tropical Forestry and Environment Vol. 3, No. 01 (2013) 45-57.

Typical examples of Inselbergs in Sri Lanka

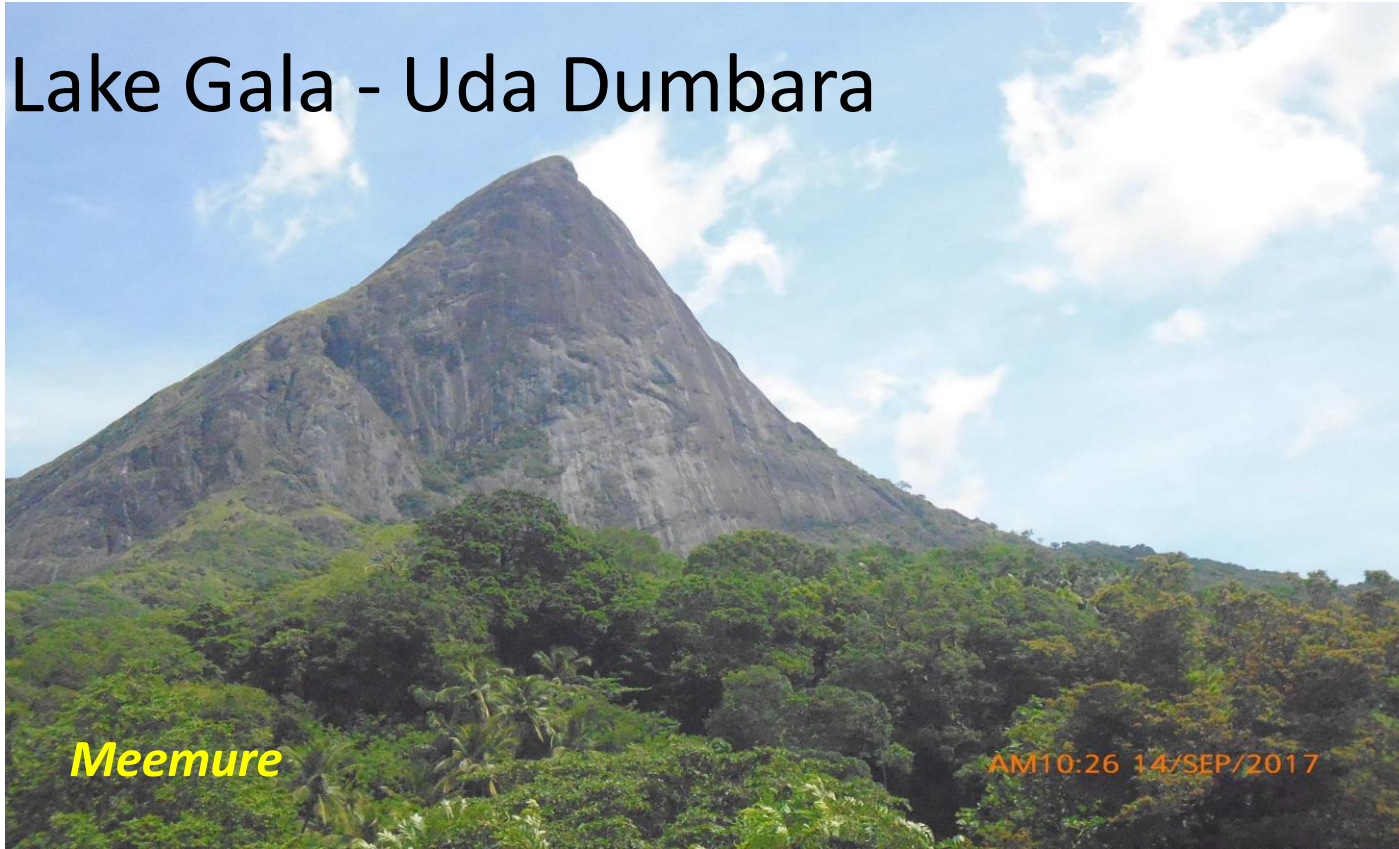
***Sigiriya,
Yapahuwa,
Etugala,
Pidurangala,
Mihintale,
Ridivihara Complex, and
Lakegala (near Meemure),
Wellegala
WestministerAbbey (Govindahela)
Aligala (Eliphant rock)
Human Face Rock)
Buddangala
Dimbulagala
Danigala circular rock***



Figure 6: Jungle swathes the eastern face of the Sigiriya rock, topped with the citadel built by King Kashyapa I - in the late fifth century A.D. in central Sri Lanka. Image © Jinadasa Katupotha 2014.



Lake Gala - Uda Dumbara



Meemure

AM10:26 14/SEP/2017



Ecology surrounding the Inselbergs

On a global scale, have made a significant contribution to speciation events in animals. Moreover, since many of the species that occur on inselbergs are limited to small, isolated populations that cannot exist elsewhere, except on other inselbergs, isolated granitic outcrops merit special attention from conservationists.

Animal Species Closely Associated with Inselbergs in Sri Lanka: Elephants, Bears, Dotted deer, Wild boar, Wild buffalo, Elk (Sri Lankan sambar), Weli muwa or Olu muwa, Wild cat, fox, Sri Lankan leopard (*Panthera pardus kotiya*), and Rilawa (Toque macaque), Kalu Wandura/Kola Wandura/Purple-faced Leaf Monkey (*Trachypithecus vetulus*) etc.

The gunmen shot and kill animals for meat, a n d skin and to collect horns, teeth, etc.



Hawks and owls frequent the inselbergs as places of food and shelter, as do gemsbok (*Oryx*), hyenas (*Crocuta*), and other mammals.

Where the soil is too thin or hard to support tree life in large areas, soil trapped by inselbergs can be dense with trees while the surrounding land contains only short grass.

Hollows in the rock surfaces provide catchments for rainwater.

Many animals have adapted to the use of inselbergs, including the lion, and the hyrax, and an abundance of bird and reptile life.

Insects like bees and wasps (Bambara or Debara) also adapted to inselbergs, e.g. Sigiriya, Pidurangala, Gowindahela, etc.



Thus, Inselbergs are isolated and rise above a plain that consists of hard bedrock. If they have a soil cover, then this is very sparse.

They vary in height depending on their development, and they take on different forms, as far as both ground plan and cross section are concerned, according to their genesis and lithology.

Microforms caused by weathering can have formed on the rock surfaces.

Inselbergs enrich their surroundings with nutrients via drainage, amounts of total nitrogen, nitrate-nitrogen, and potassium in rainfall, drainage from bare rock patches, and vegetation mats (cover) on an inselberg.

Vijayan Complex

The Vijayan Complex (VC) of eastern and southeastern Sri Lanka is one of three high-grade metamorphic terranes making up the basement of the island and is in tectonic contact with the adjacent, older Highland Complex.

It consists predominantly of granitoid gneisses ranging in composition from diorite to leucogranite, with a distinct calc-alkaline geochemical signature, and is interpreted as a magmatic arc.

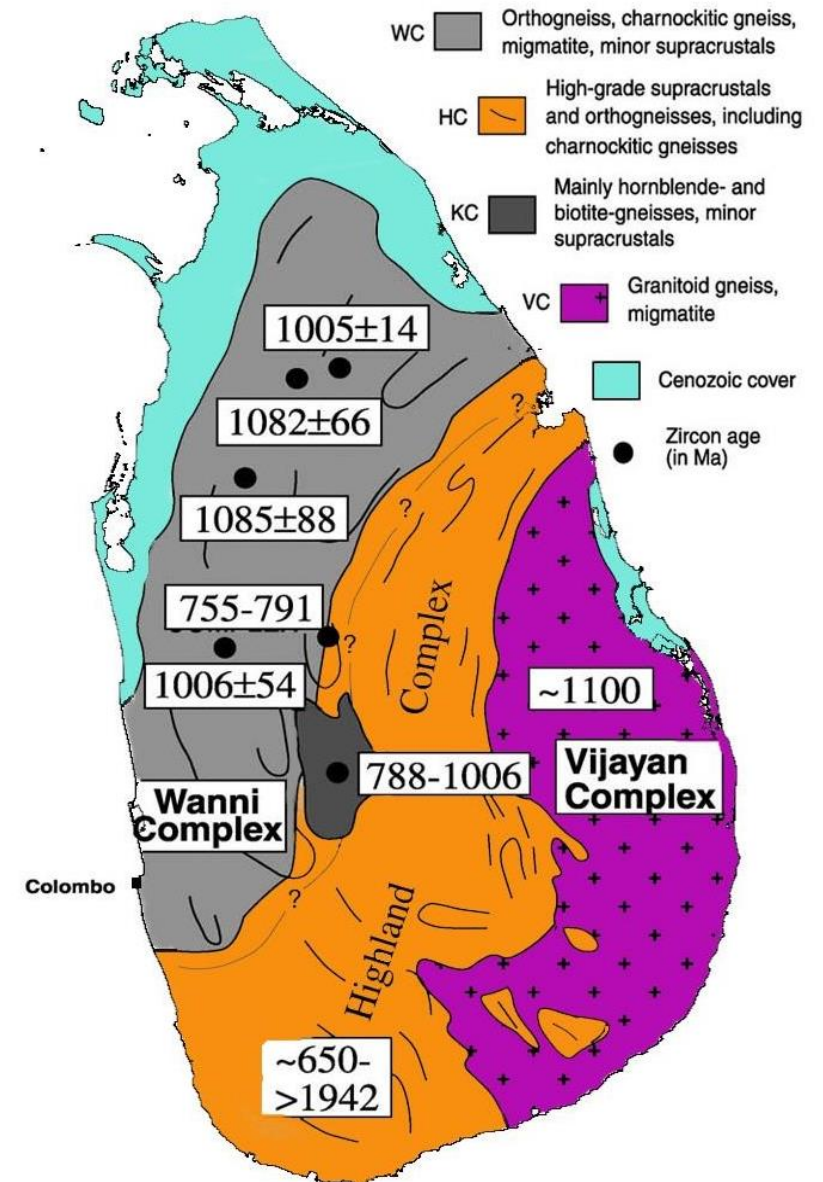


Figure 4: Main Geological Zones of Sri Lanka, including specific dating. (Coory 1984; Kroner et al 1991; Kehelpannala 2003; 2017)



Strong ductile deformation has obliterated almost all original intrusive relationships.

High-grade metamorphism during the Pan-African event at ca. 610–520 Ma has produced widespread granulite-facies assemblages that are now largely retrogressed and were affected by extensive late metamorphic K-metasomatism.

In southern Sri Lanka, the Vijayan gneisses are tectonically interlayered with rocks of the Highland Complex in a so-called mixed zone.



Research Objectives

Objective 1:

All the inselbergs were located using available topo sheets, satellite images, and Google images to prepare an inventory.

Objective 2:

Collect data (location with lat/lon, height, and extent).

Collect data in relation to water pools, microbiology, faunal, and flora.

Objective 3:

Building a network for the shortage of proper management and route guide for geo-touristic purposes in eastern Sri Lanka

Objective 1:

1. Generation of Contours

- Extracted the Salletite data (DEM/images)
- Generated the DEM/contour for the study area using ArcGIS Pro

2. Identification of Inselbergs

- the Vijayan Complex was divided into 48 grids (500m x 500m)
- Extracted the inselbergs with **more than 100m height for the background**

3. Extracting the Lithological data

- Contours are overlaid on the Georeferenced Geological maps; Scale = 1 to 100 000
- Identified the Lithology of each inselbergs

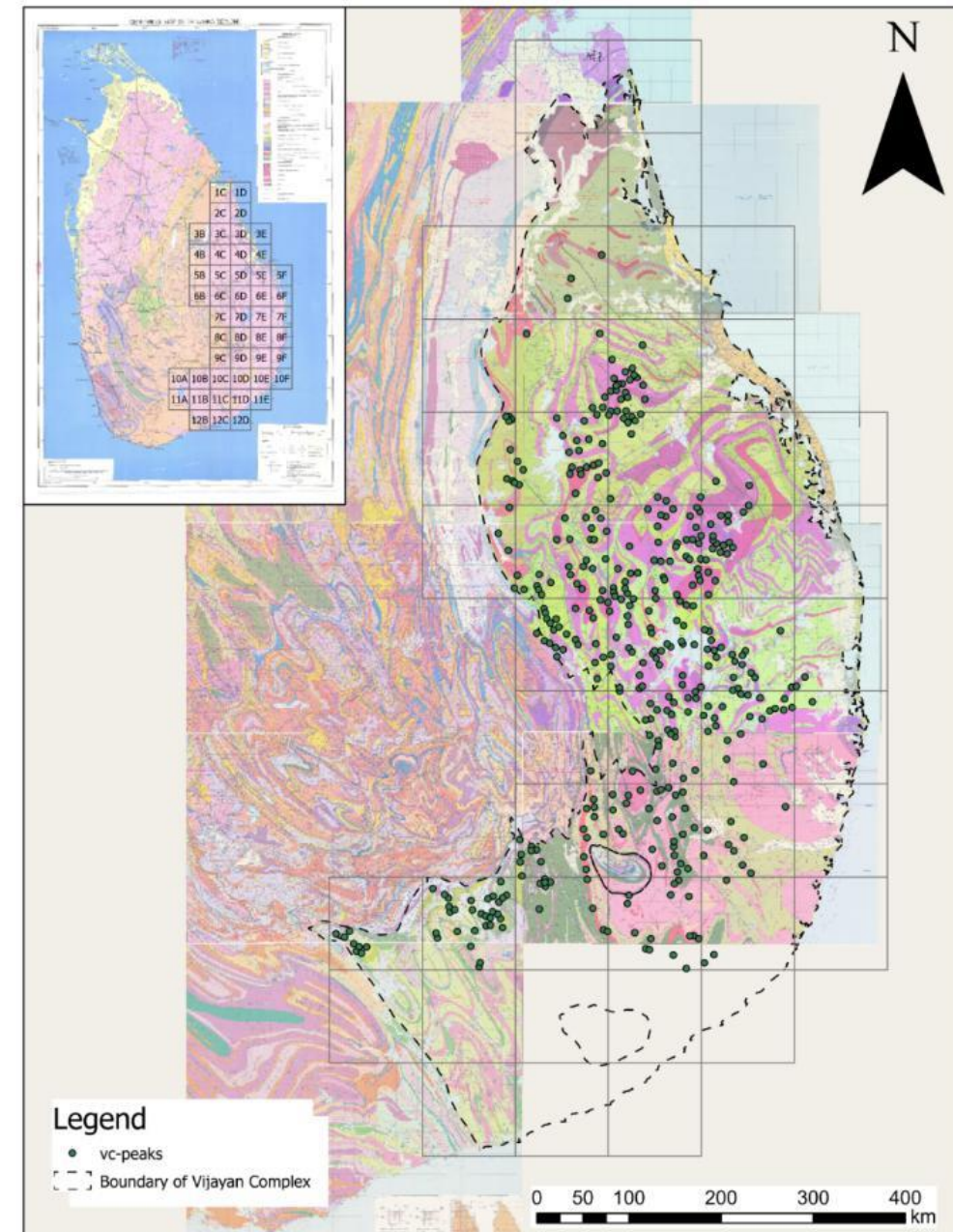


Figure 7: The legend map for the grids

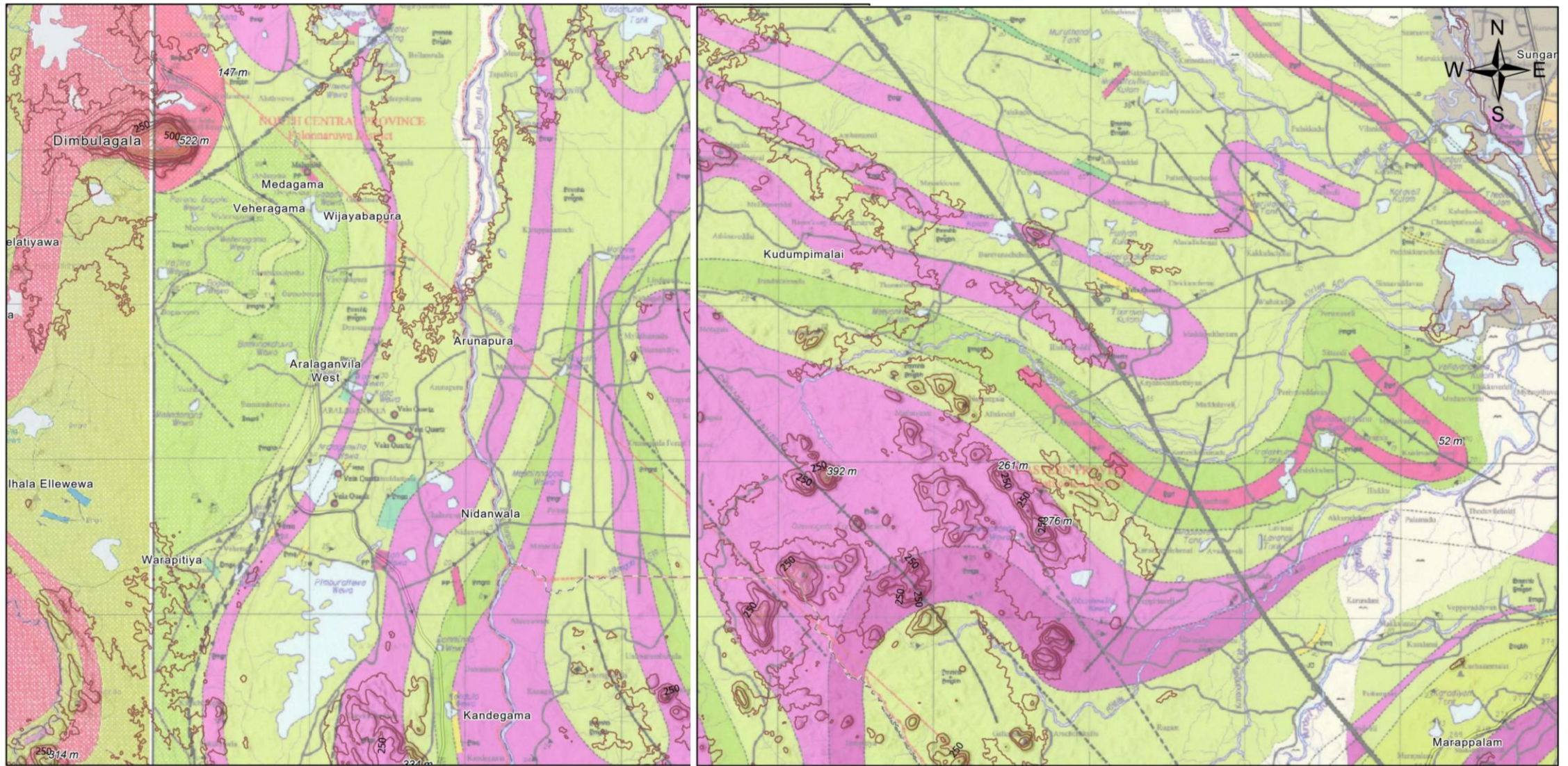


Figure 8: Two consecutive grids with the contours overlaid on the geological maps to identify the lithology



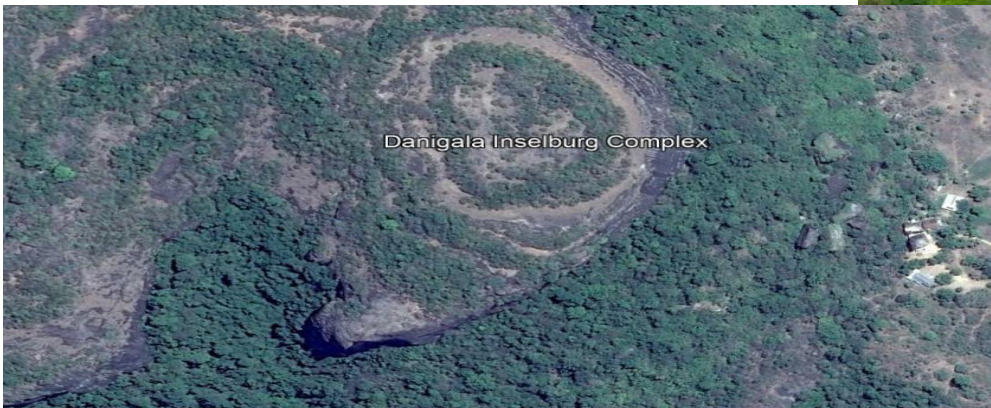
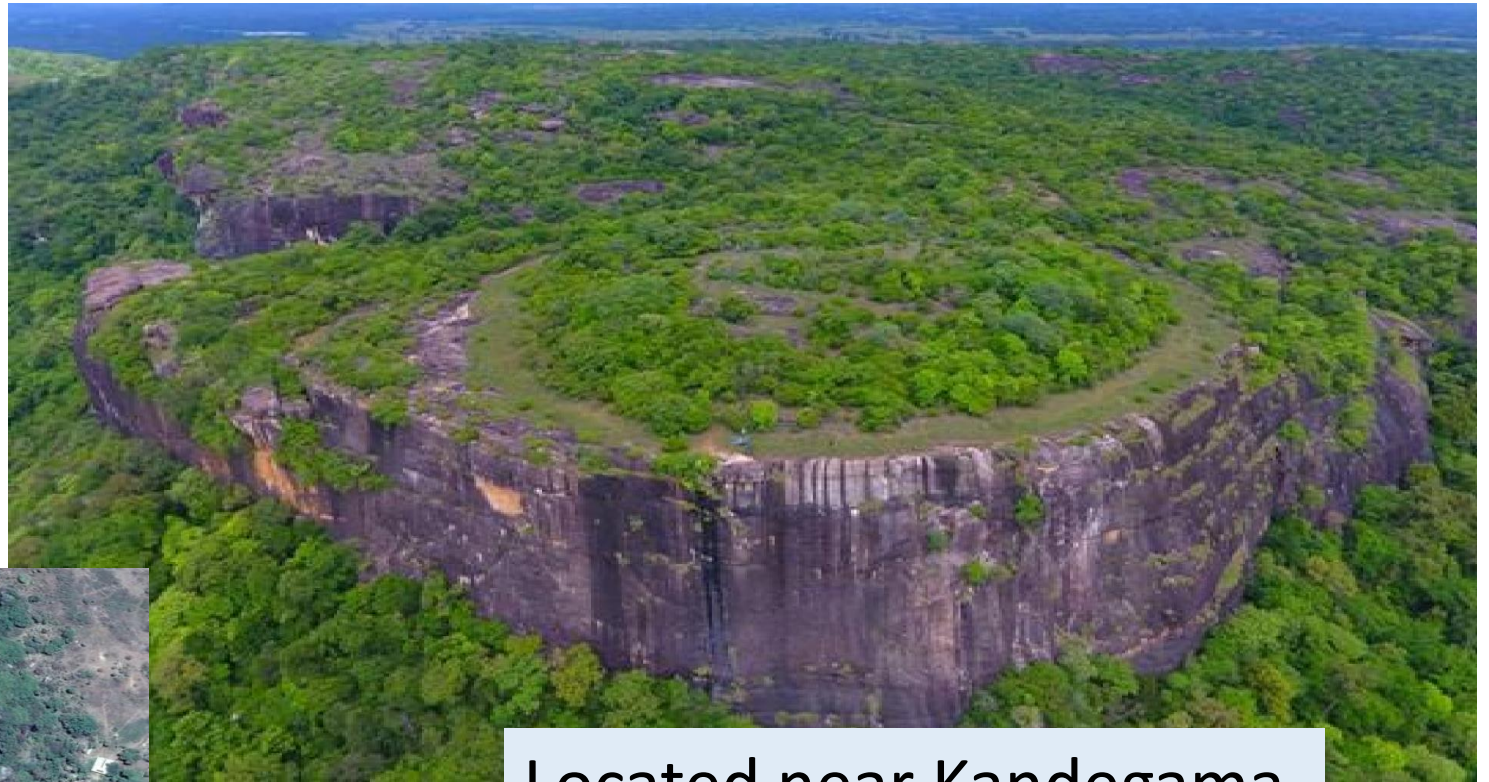
Important Results

- **Identified well famous inselbergs (see images)**
- **Categorized the inselbergs of the VC (See Table 1)**
- **Summery of the field study**



Results and Discussions

Danigala Inselberg Complex



Located near Kandegama
in the Polonnaruwa
district.



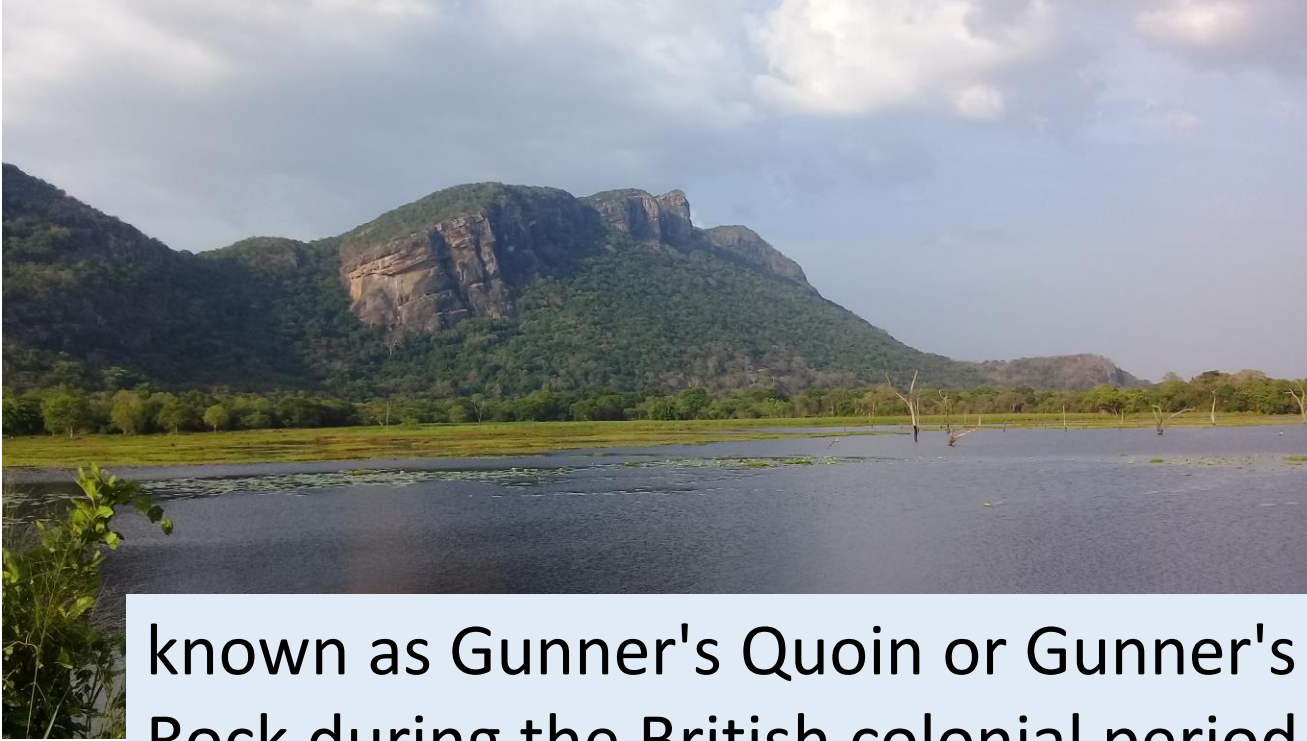
Govinda Hela (Westminster Abbey)



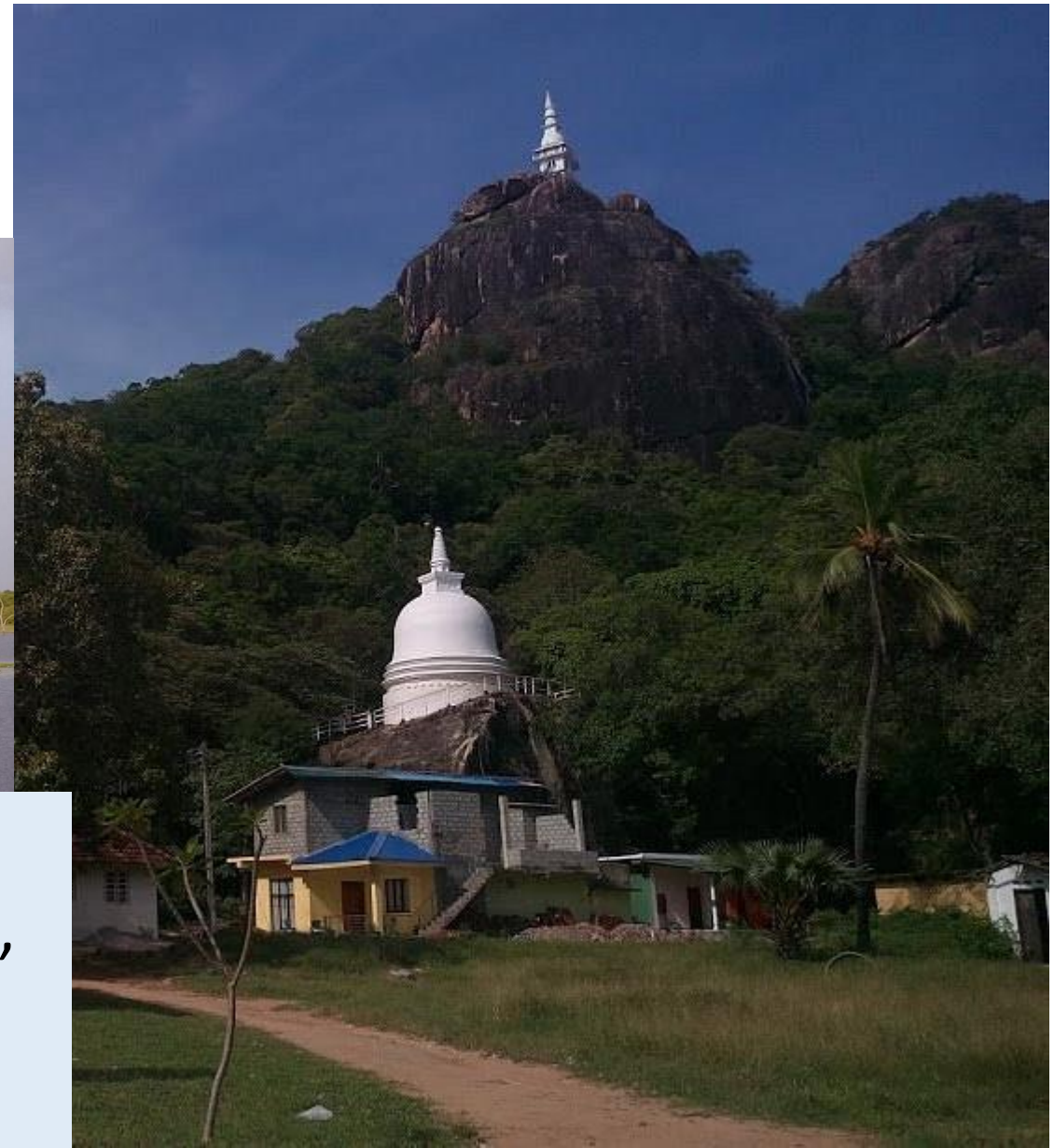
Located in
Siyambalanduwa, on the
border of the Ampara
District in the Eastern
Province (558m).



Dimbulagala

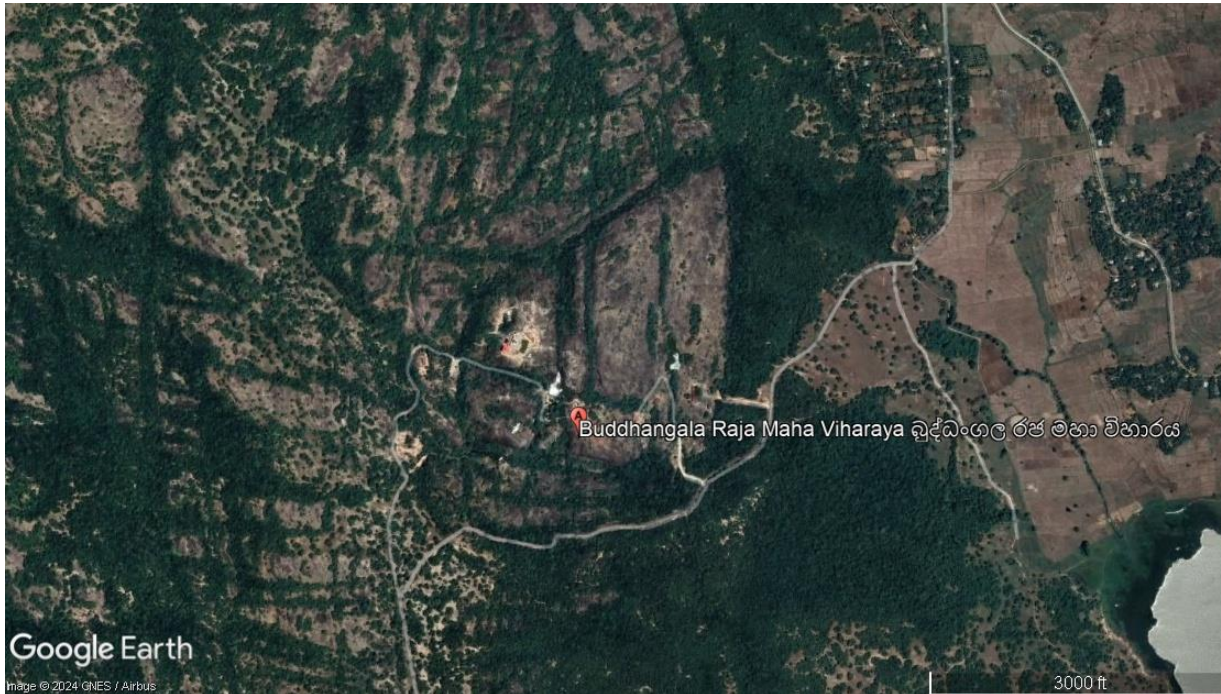


known as Gunner's Quoin or Gunner's Rock during the British colonial period, located in the Polonnaruwa District of Sri Lanka.





Buddangala



Rising above the forest north of Ampara, this 150m-high hill offers panoramic views from its rocky summit

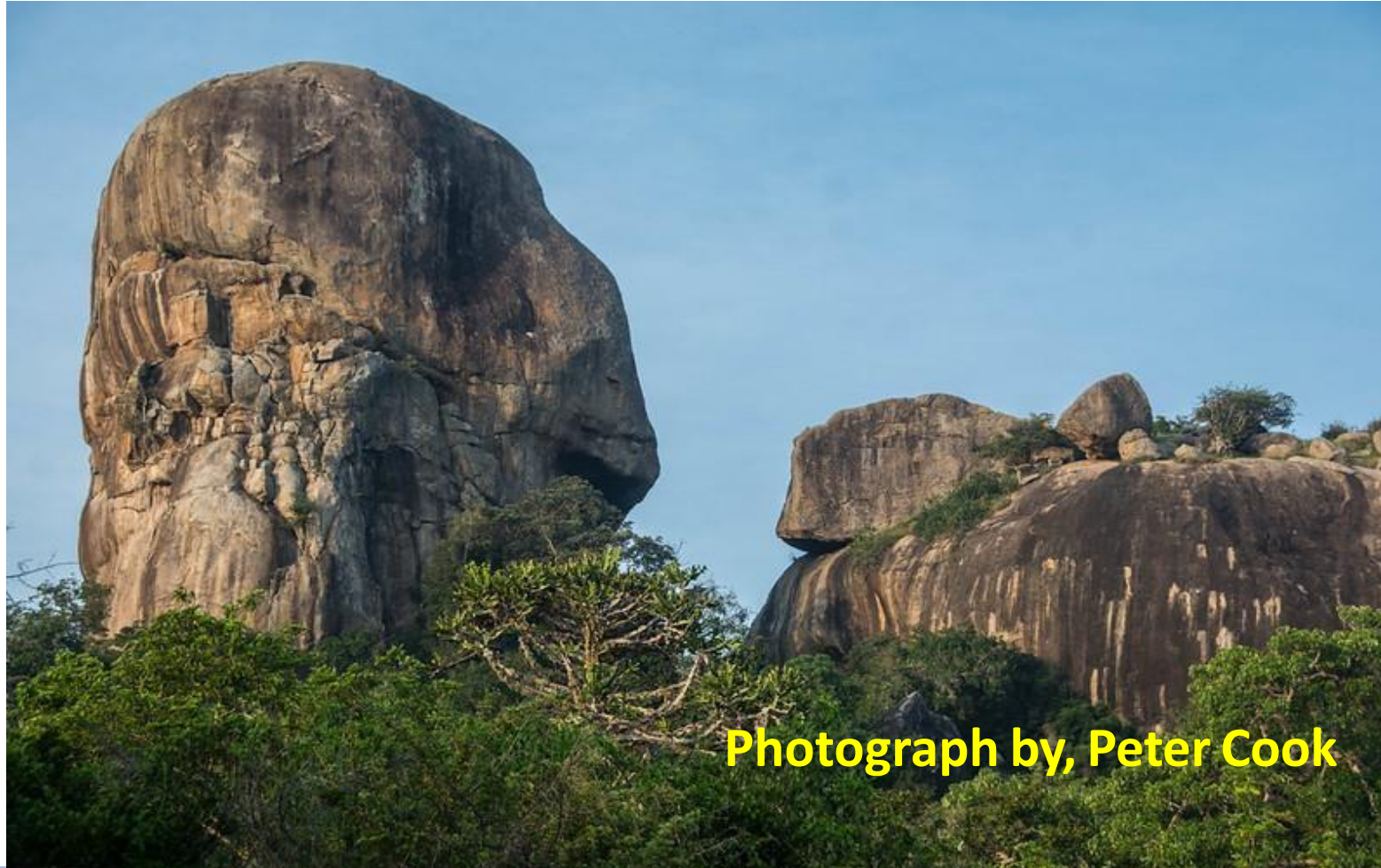


An inselberg ridge at Bibile





Human Face Rock, Yala National Park, Sri Lanka



Photograph by, Peter Cook



Elephant Rock (Ali Gala) , Yala National Park, Sri Lanka





Table 1: The identified Lithologies of the inselbergs in Vijayan Complex

Abbreviation	Name	Count	%
pmgr	granite gneiss	163	34.4
pmmhb + pmgbh	hornblende biotite migmatite	80	16.9
pgrf	alkali feldspar granitic / gneiss / migmatite	71	15.0
pmgbh	biotite hornblende garnet gneiss	51	10.8
pmgrd	granodioritic gneiss	15	3.2
pmgrf	microcline gneiss	15	3.2
pmgk	charnockitic gneiss	14	3.0
pmgb	biotite gneiss	12	2.5
pmgga	garnet sillimanite biotite gneiss	11	2.3
pmgrh	granitic gneiss	10	2.1
pmgrhy	Quartzofeldspathic gneiss	9	1.9
pmq	quartzite	8	1.7
pmghb	hornblende biotite gneiss	6	1.3
pmgqf	garnetiferous quartzofeldspathic gneiss	5	1.1
pmmhb	hornblende biotite migmatite	4	0.8
		474	100



Summary Field study

- A total of **474** inselbergs were identified from **Ampara District**
 - 34% - granite gneiss
 - 17% - hornblende biotite migmatites.
 - 15% - alkali feldspar granitic gneiss/migmatites and
 - 11% - biotite hornblende garnet gneiss.
- High weathering resistance of the rocks is the reason for the formation of such inselberg



Conclusions

- **Inselbergs are scattered in the II & III Planation Surfaces of Sri Lanka, mainly Dry zone.**
- **Inselbergs are exceedingly composed of granites or gneissic rocks of VC.**
- **Geology, micro-relief and microclimatic conditions on Inselberg and their surroundings support to form of xeric habitats.**
- **The enclosed area of the outcrop shows considerable differences in plant species, particularly tree species, leguminosae, linaceae and other bushes.**
- **Most of these local floras are being used widely for different purposes including medicinal usage.**
- **Therefore undertaking detailed research and conservation of granite inselbergs, fauna and flora is highly essential.**



FUTURE DIRECTIONS (RECOMMENDATIONS)

- It is necessary to undertake detailed study and collection data with lat/lon, height, and extent, and prepare a inventory of VC inselbergs, and should be consider all as *natural and national heritages*,
- Categorized the inselbergs using geology, height, climatic zones wise,
- Preserve inselbergs and associated caves as existed cultural, archaeological, anthropological, tourism and zoological sites,
- Building a network for the shortage of proper management and route guides for geo-touristic purposes in eastern Sri Lanka
- Encourage A/L students to undertake their Project Reports emphasizing Geography, Zoology, Biology, Chemistry, Microbiology etc.
- Encourage University students to undertake research emphasizing Ecology, Tourism, Geography, History, Archaeology, paleontology, Geo-archaology.



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Note: Use Referencing guidelines in the GSSL website

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