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The many branches of the tree; a personal view of Palaeobotany in Africa

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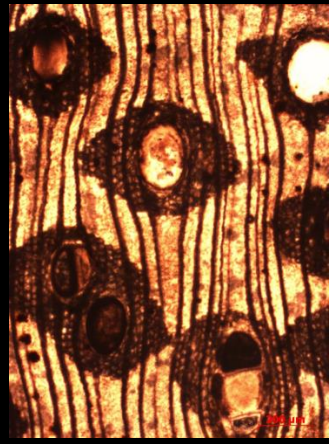


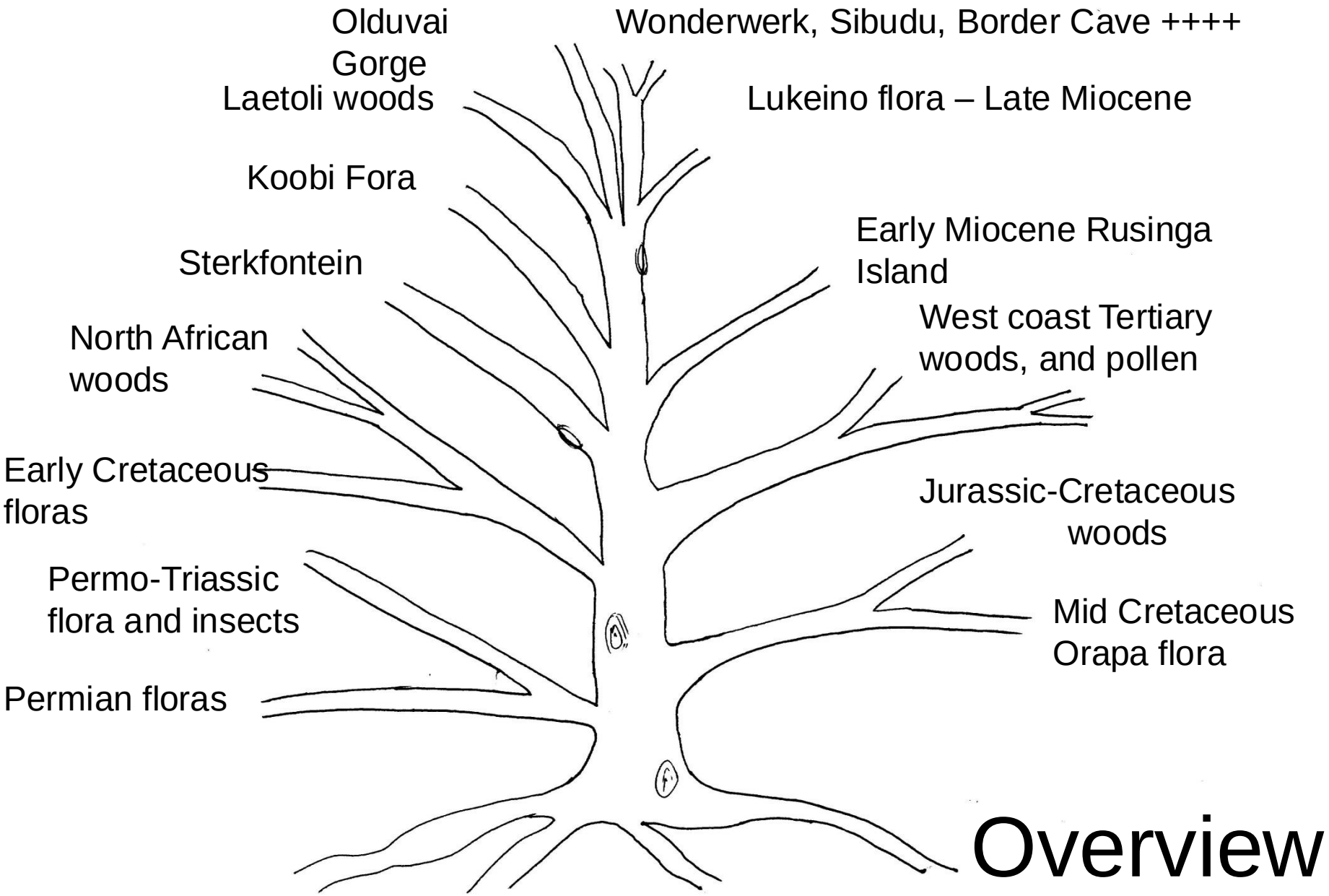
The many branches of the tree; a personal view of Palaeobotany in Africa

Marion Bamford

Inaugural lecture

University of the Witwatersrand

15 May 2014


Olduvai Gorge
Wonderwerk, Sibudu, Border Cave ++++
Laetoli woods
Lukeino flora – Late Miocene
Koobi Fora
Early Miocene Rusinga Island
Sterkfontein
West coast Tertiary woods, and pollen
North African woods
Early Cretaceous floras
Jurassic-Cretaceous woods
Permo-Triassic flora and insects
Mid Cretaceous Orapa flora
Permian floras
Overview

Wits experience

- Botany and Microbiology
- Palaeontology
- BPI/ESI
- Wood anatomy training
  - MRAC Brussels
  - Paris VI
  - Univ Claude Bernard, Lyon
  - Univ La Plata, Argentina





Africa and Palaeobotany

North Africa
Tanzania
Kenya
Botswana
Zimbabwe
Namibia
Botswana
Mozambique
South Africa



Lawley (Early Permian- approx. 280 Ma)
Glossopteris flora; SA coal

Tertiary

Cretaceous

Jurassic

Triassic

Permian

Carboniferous

Devonian

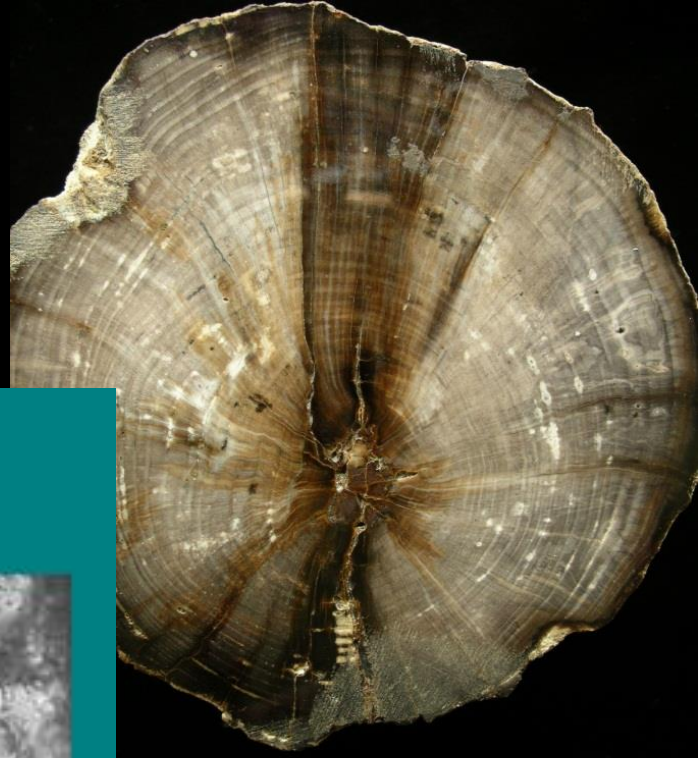
Silurian



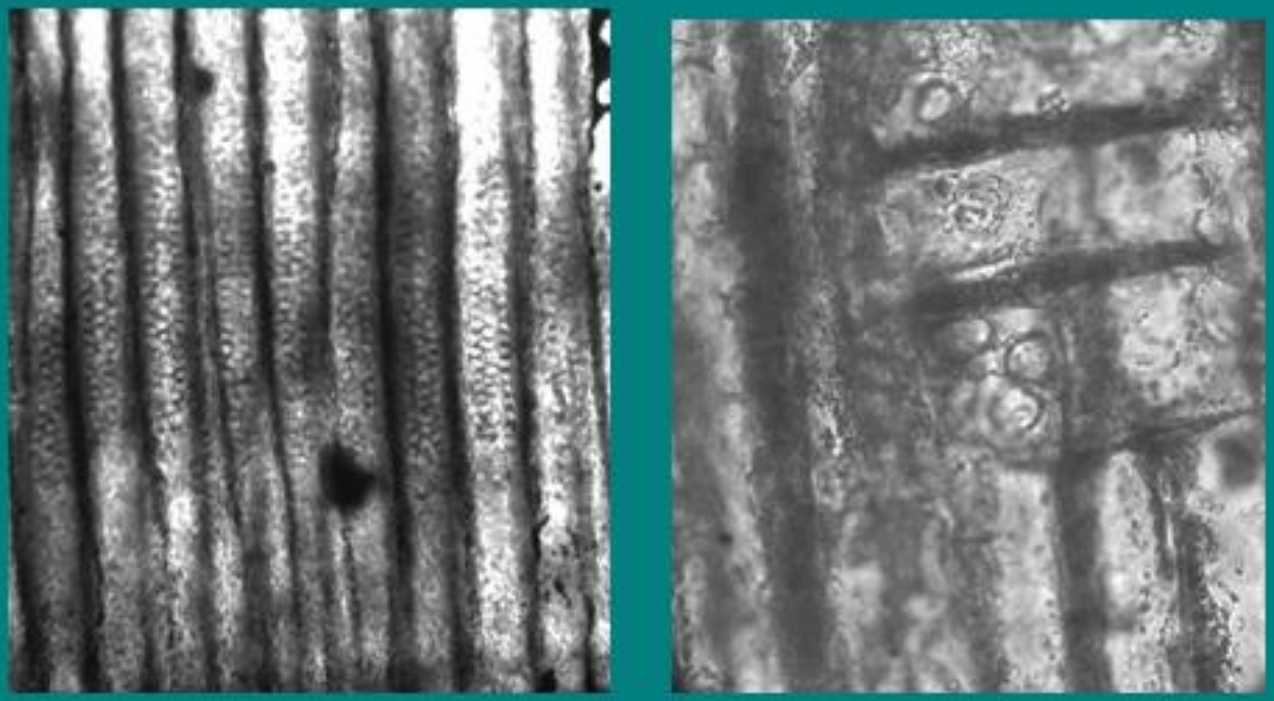


Glossopteris

Fossil woods



Agathoxylon



A. karooensis – triseriate pitting

Taxonomy
Biostratigraphy
(Palaeoclimate)

P-Tr floral and insect changes



June 2006

Tertiary

Cretaceous

Jurassic

Triassic

Permian

Carboniferous

Devonian

Silurian





Dicroidium

Tertiary

Cretaceous

Jurassic

Triassic

Permian

Carboniferous

Devonian

Silurian

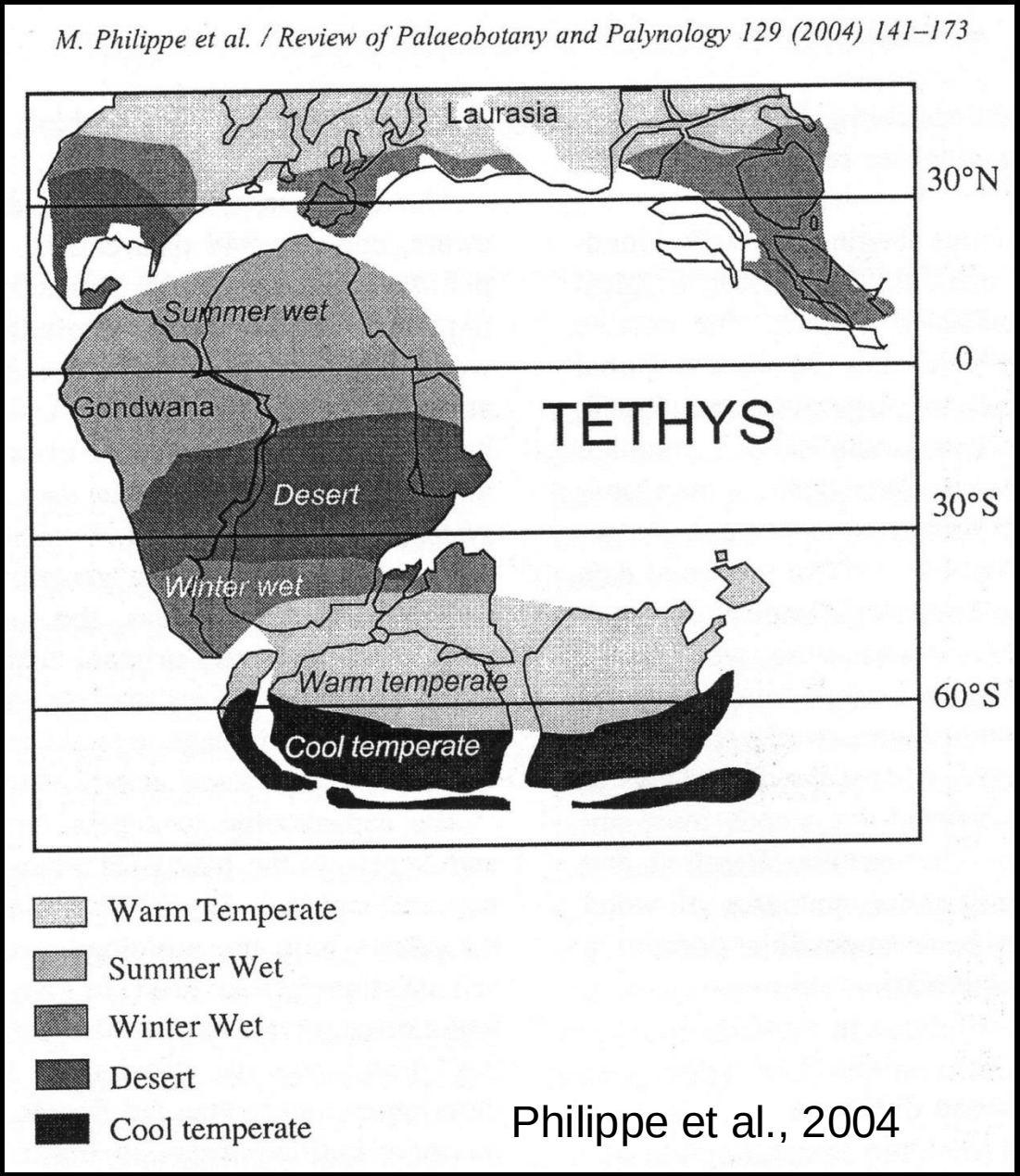






Jurassic – age of conifers

Jurassic - Cretaceous wood taxonomy



Philippe et al., 2004

Conifer biogeography

- Jurassic-Cretaceous conifers
- Taxonomy
- NB time period
- Climate-distribution
- Podocarpaceae
- Araucariaceae

Tertiary

Cretaceous

Jurassic

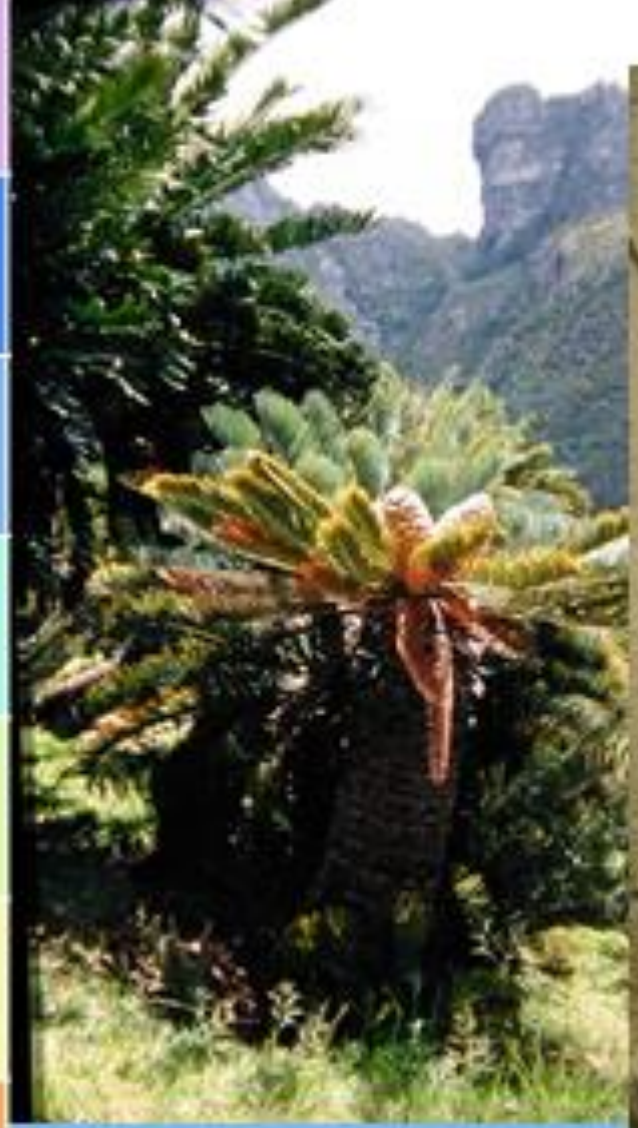
Triassic

Permian

Carboniferous

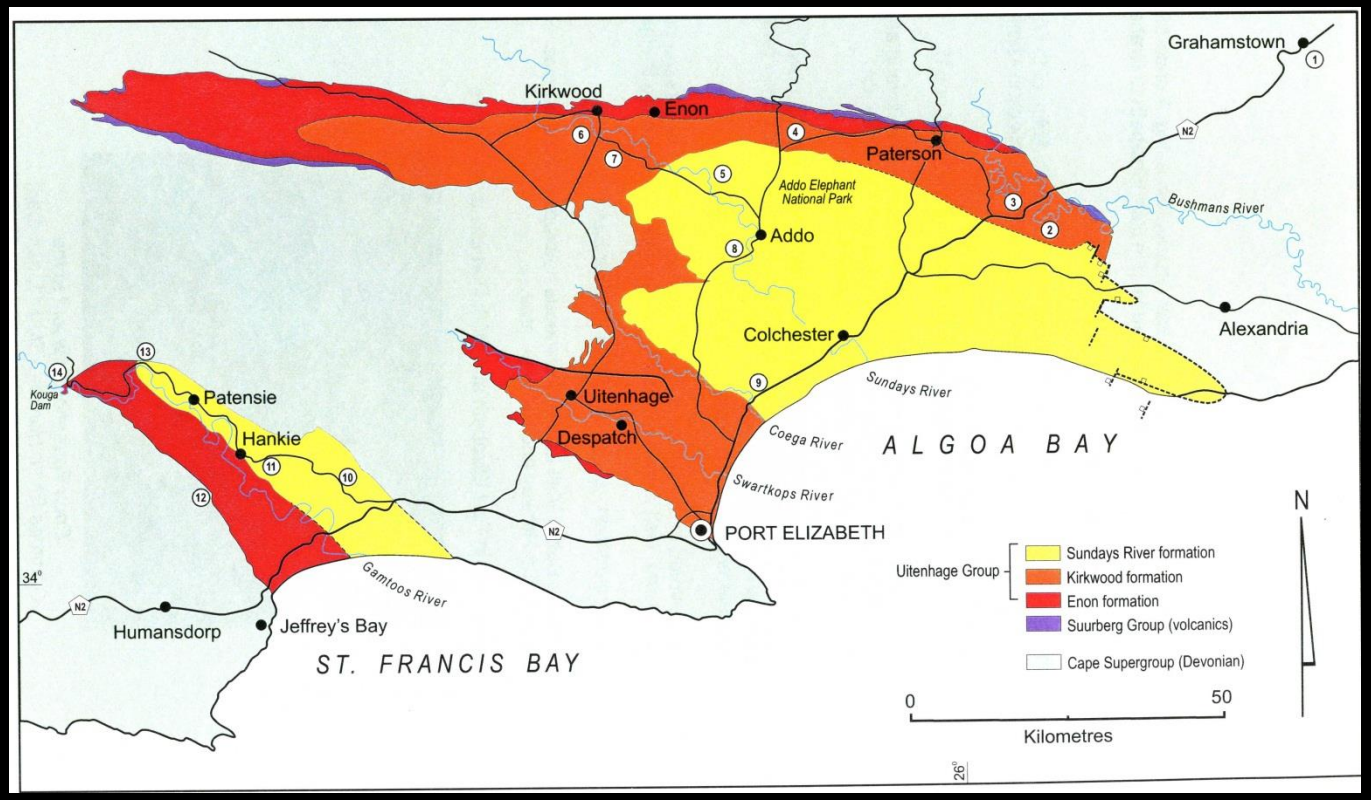
Devonian

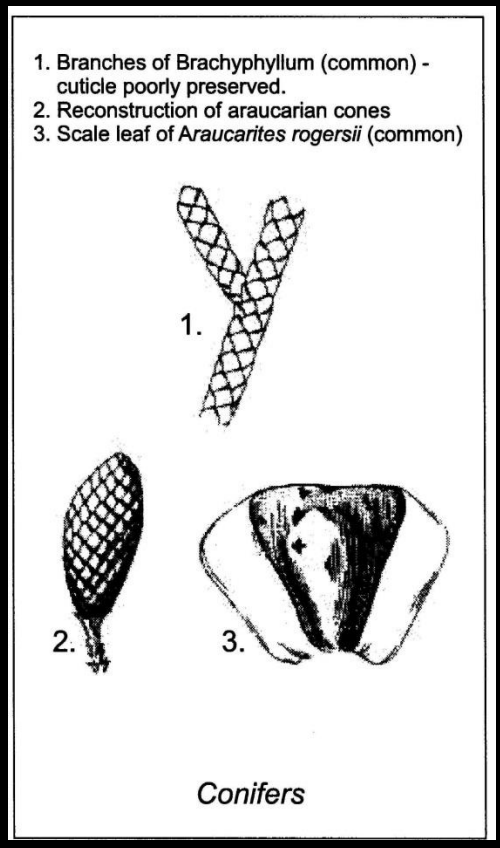
Silurian





Cycads





Kirkwood Fm, Early Cretaceous; cycads, conifers, ferns

Charcoal – 5 conifer species;

large-scale fires





Kirkwood-palaeofires project

Tertiary

Cretaceous

Jurassic

Triassic

Permian

Carboniferous

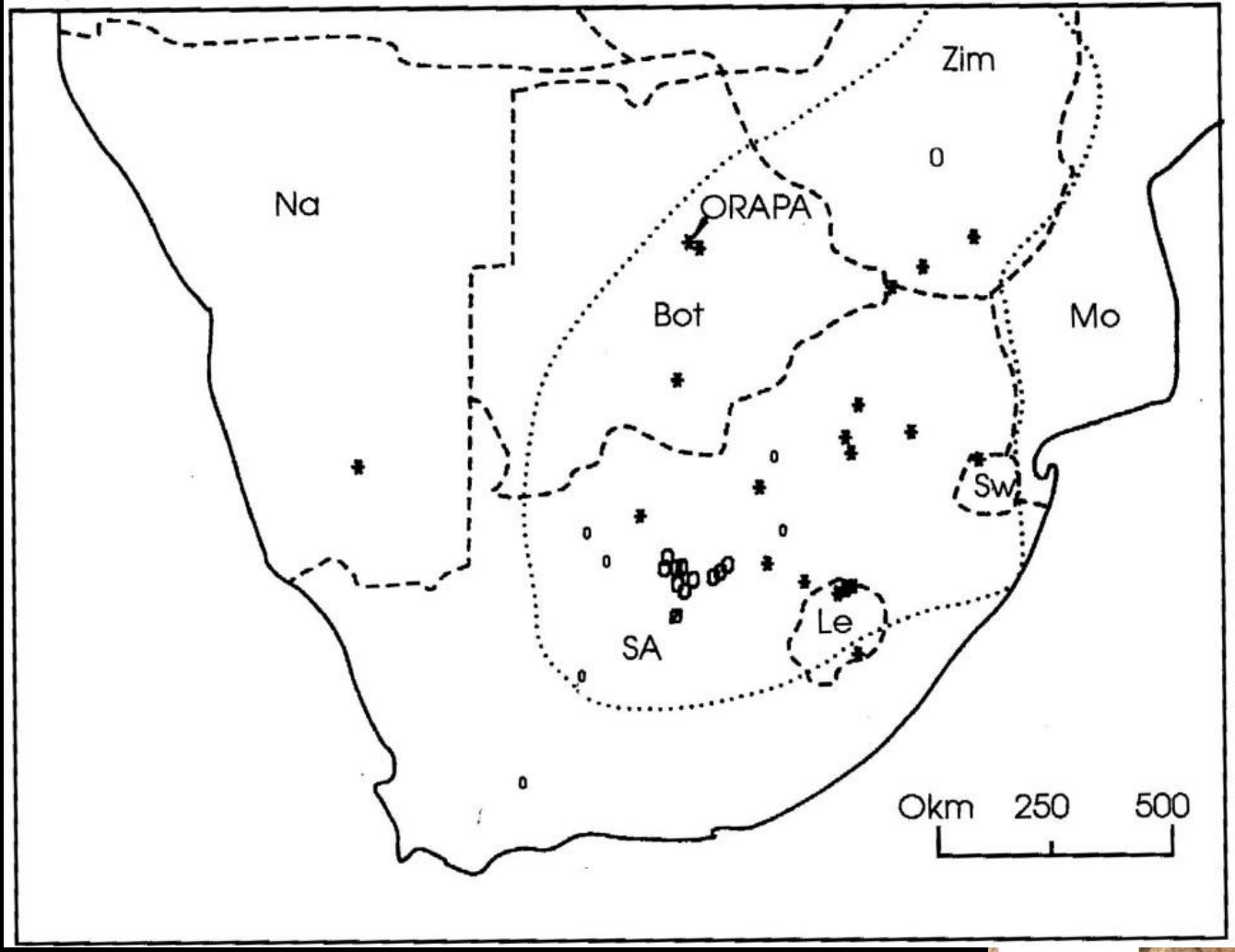
Devonian

Silurian

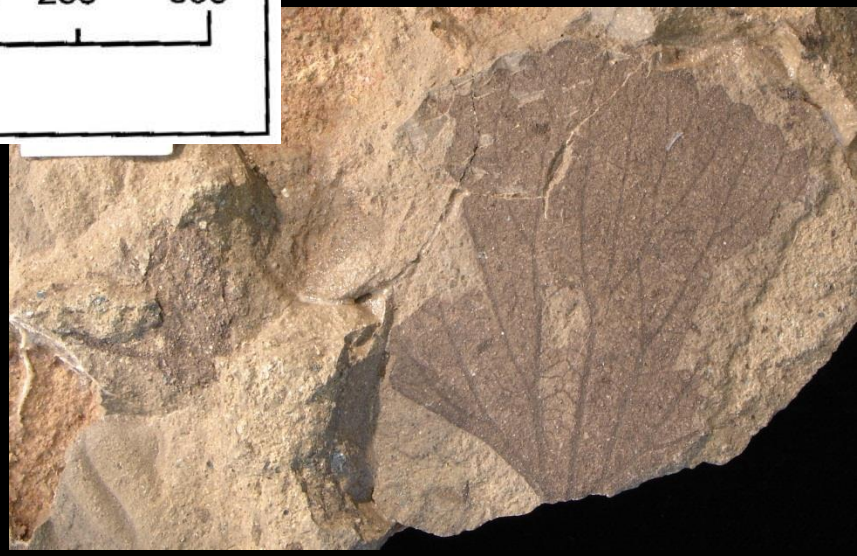




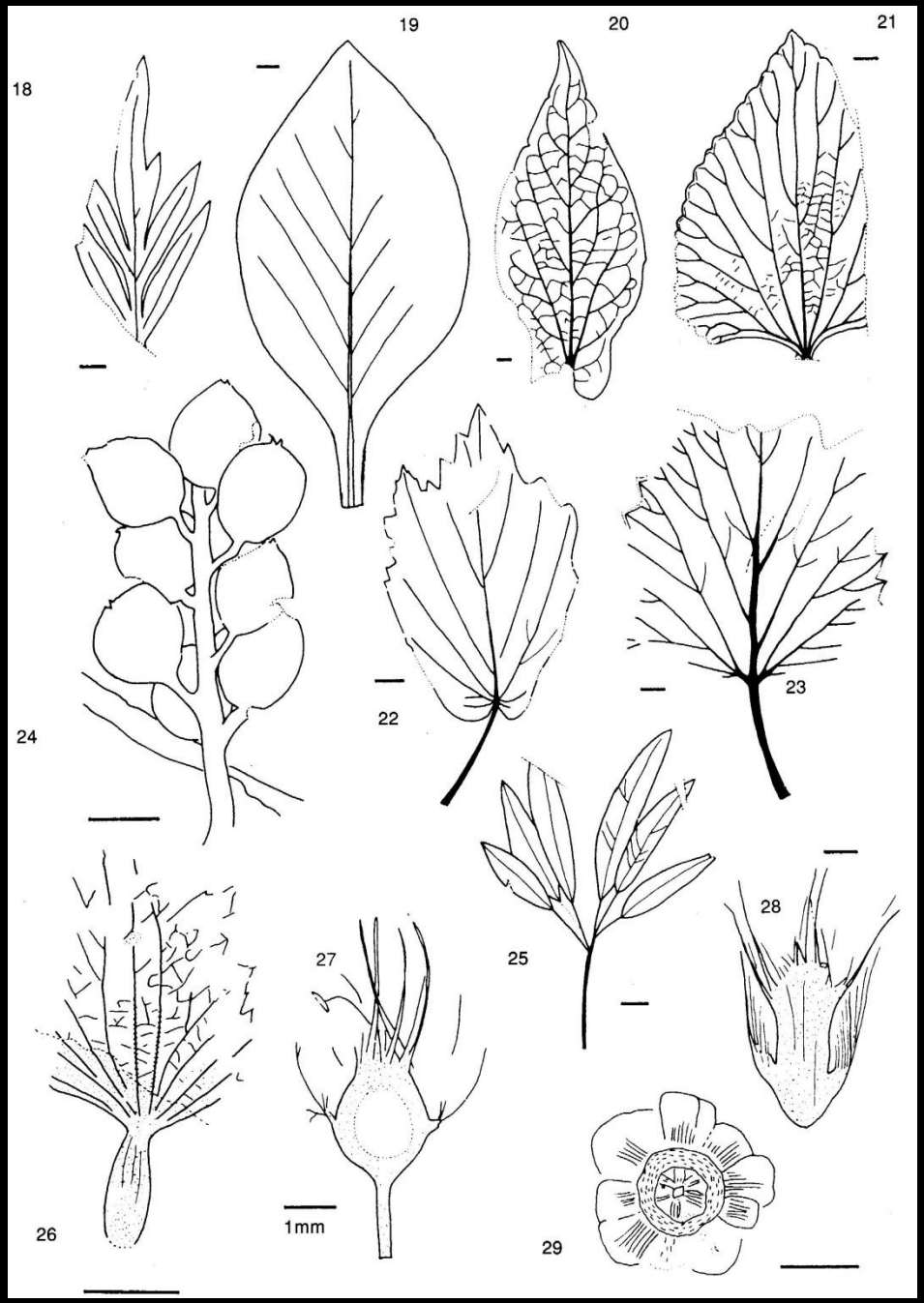
Angiosperms

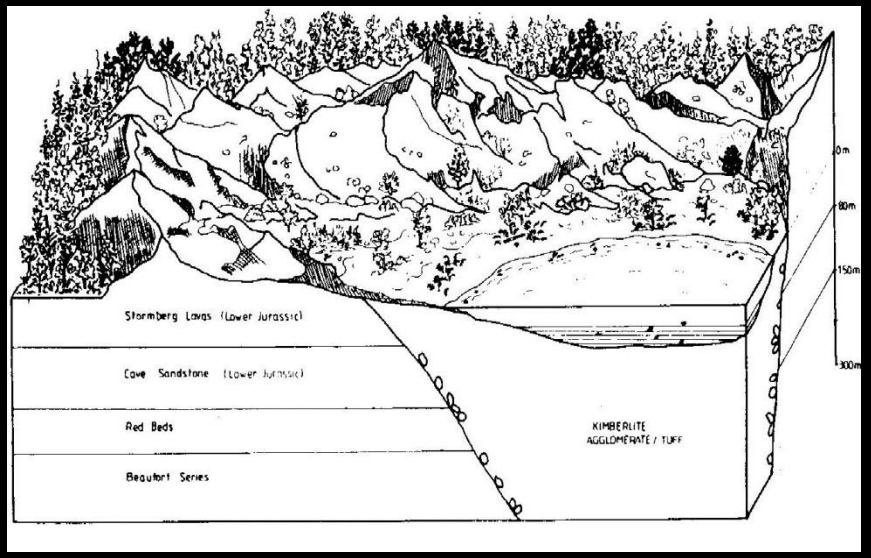






Orapa kimberlite pipe





Numerous insects
Angiosperm leaves
Ferns
NEW: climate from leaves

Late middle Cretaceous Orapa flora

African Cretaceous woods

- Early Cretaceous
- Low diversity gymnosperms
- Modern families and extinct taxa

- Late Cretaceous
- Greater diversity Conifers
- Angiosperms most diverse

- North Africa - many
- Southern Africa:

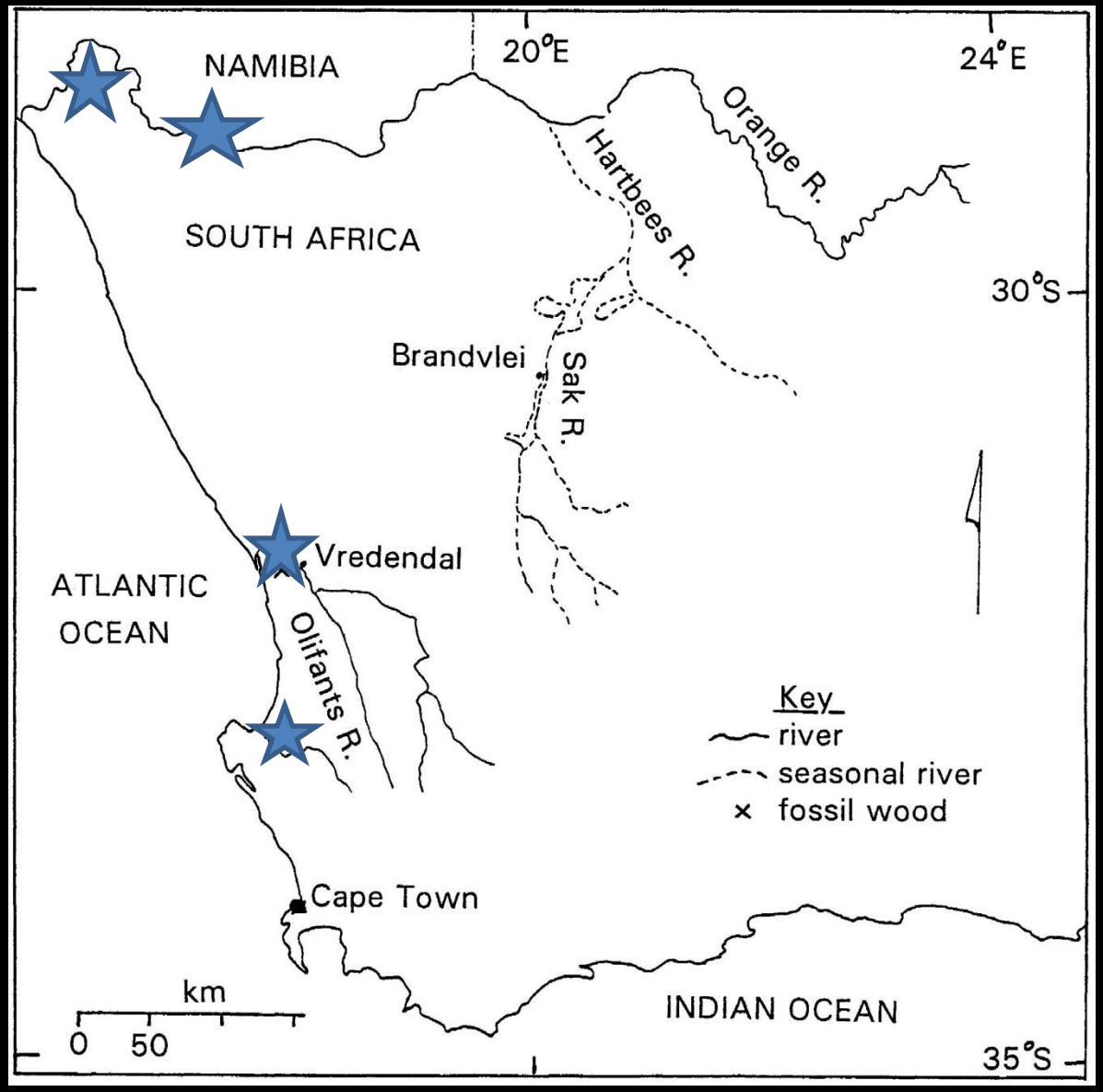
  Monimiaceae (2 taxa),

  Euphorbiaceae (4 taxa)

Tertiary flora/woods

- Eocene – angiosperms – clear family affinities and mixed
- Oligocene – one
- Miocene – well represented – west coast
- Pliocene-Pleistocene – coastal and inland
- Modern flora – very diverse

- Pollen – many species



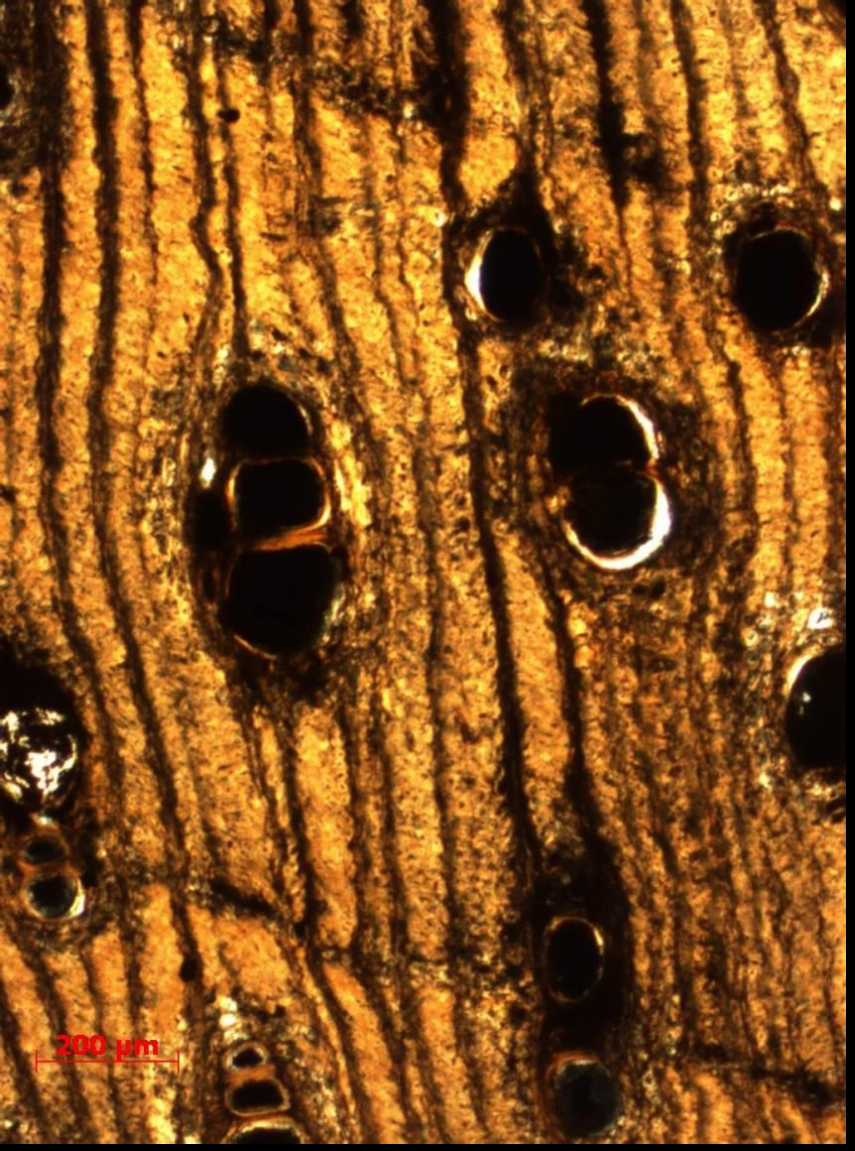
Auchas
Arrisdrift
Vredendal
Rondeberg

Anacardiaceae
Burseraceae
Combretaceae
Meliaceae

Podocarpaceae

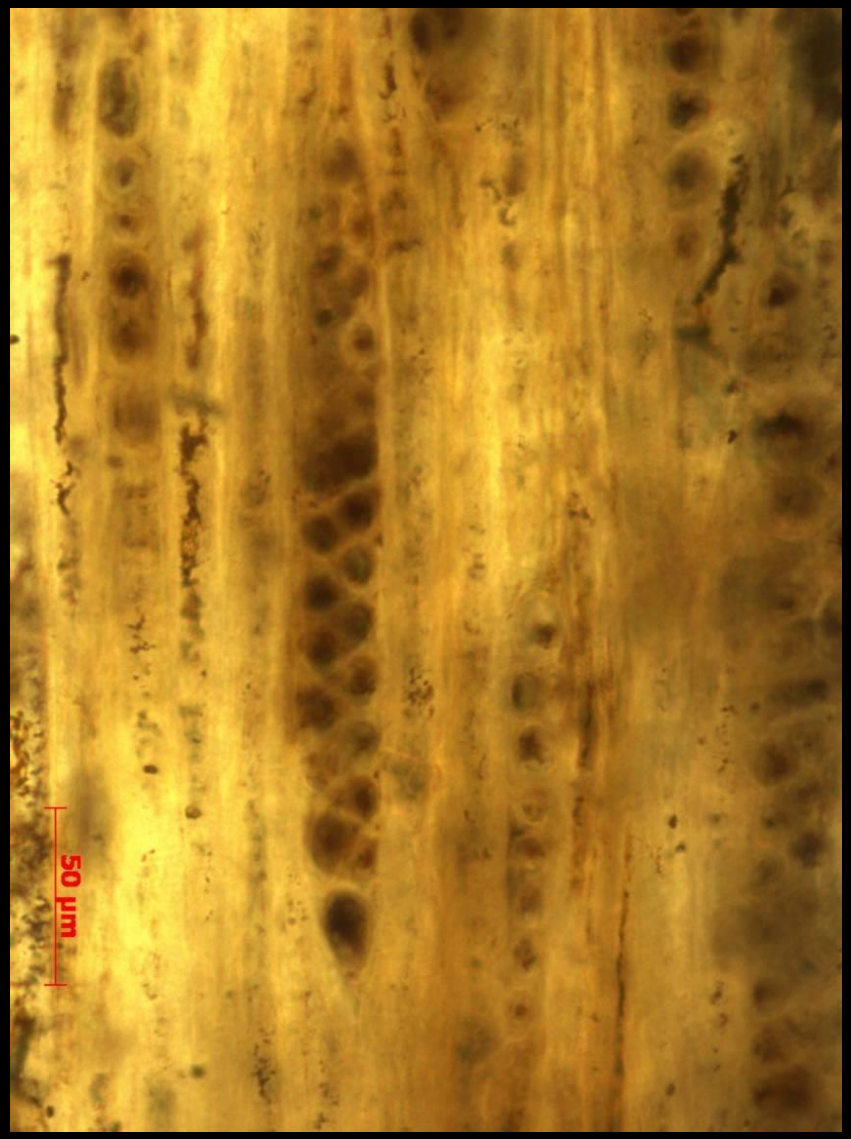
Miocene West coast woods

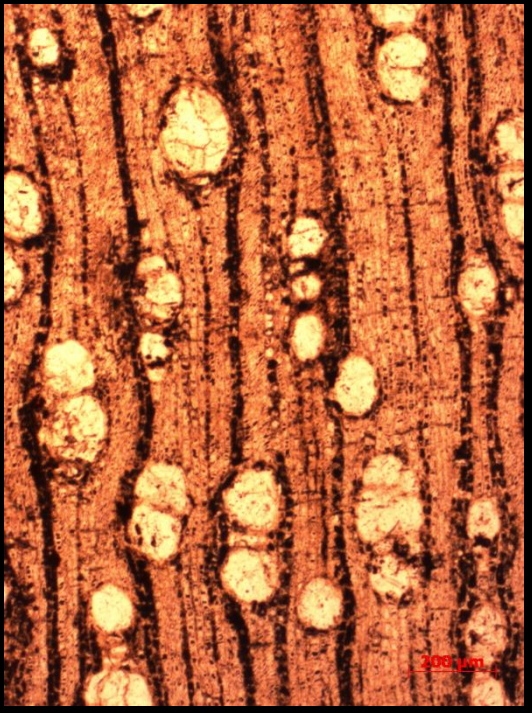
Vredendal Miocene

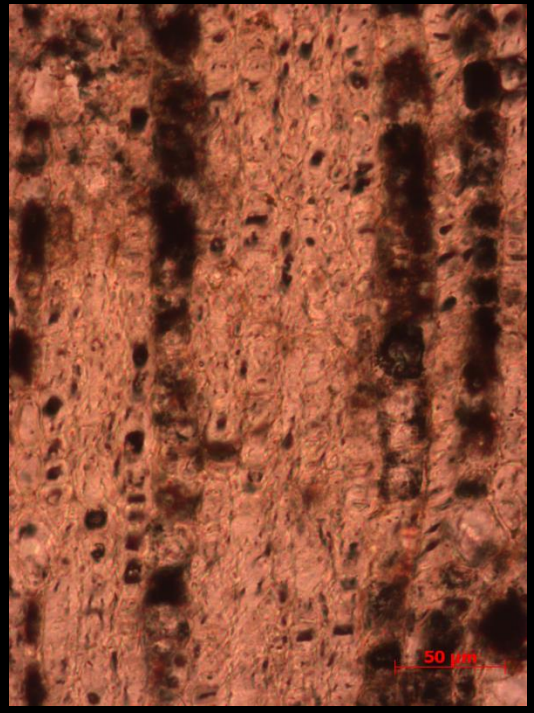


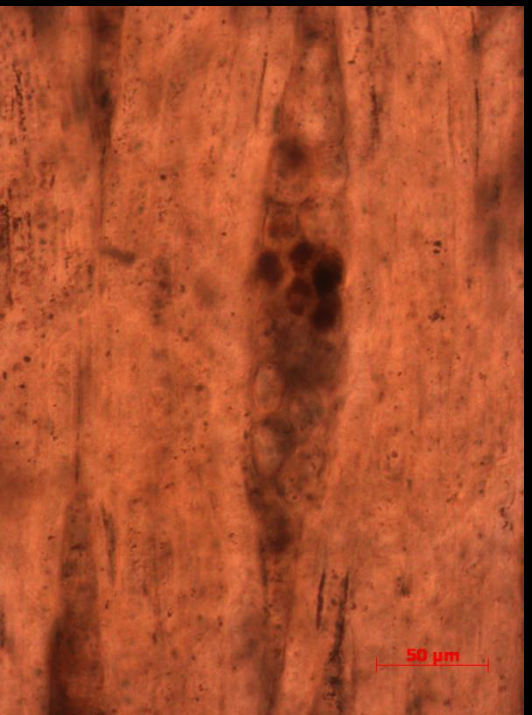
Meliaceae
Combretaceae

Bamford 1999









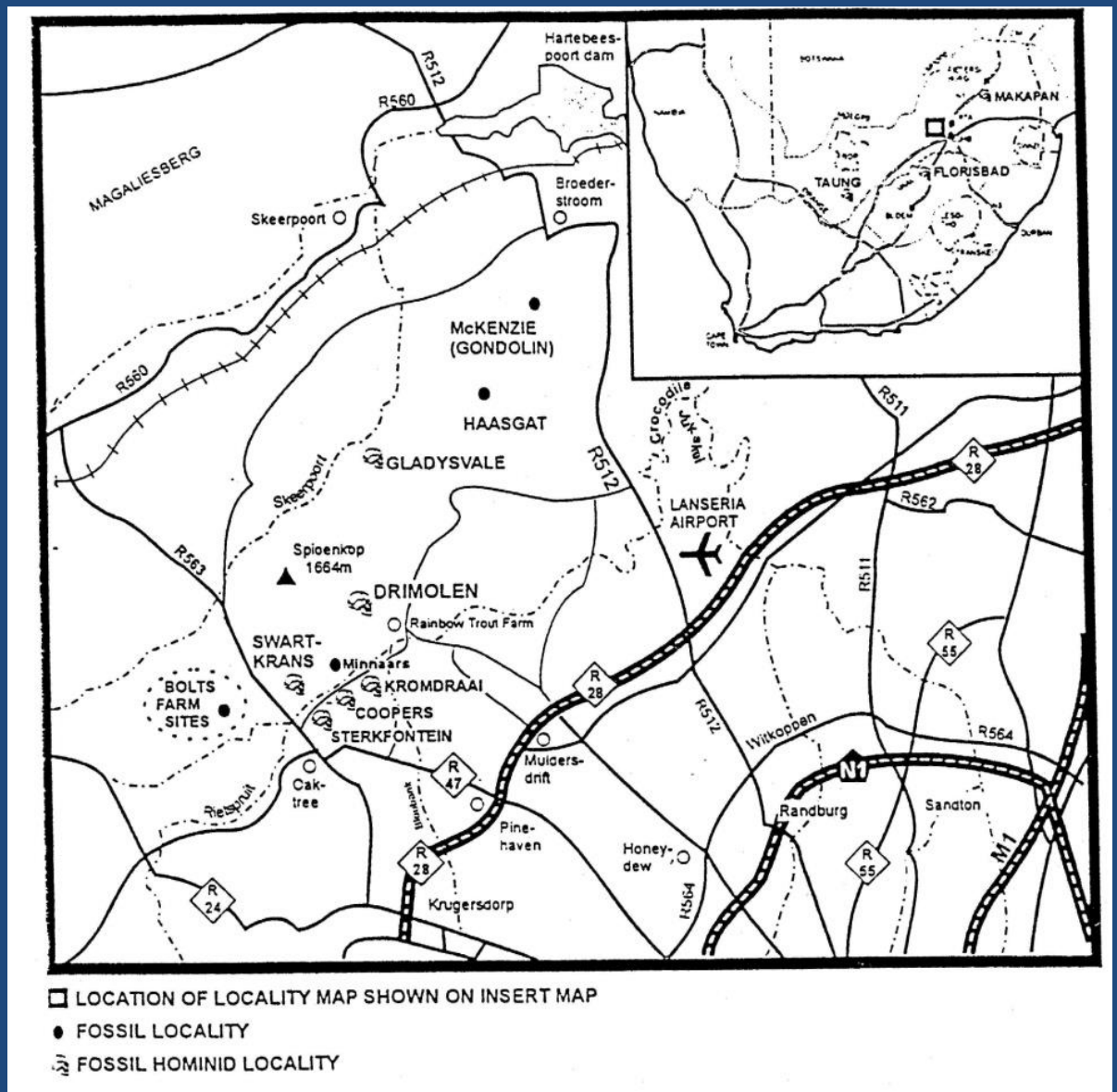


Arrisdrift
Miocene

Burseraceae
Combretaceae
Fabaceae

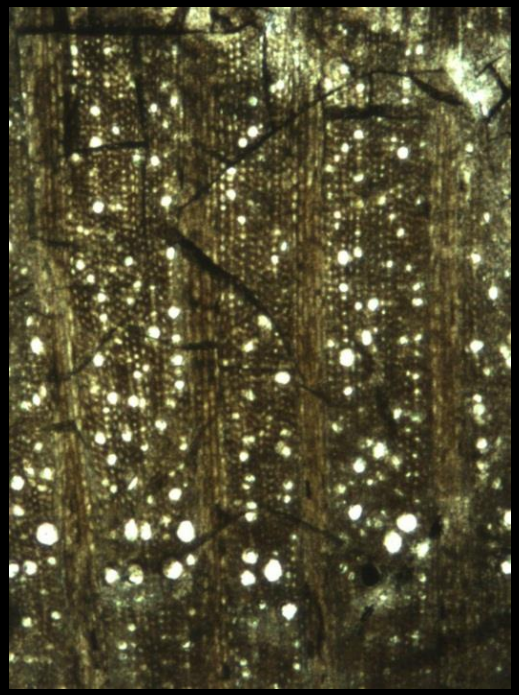
Cradle of humankind sites /Sterkfontein valley

- Sterkfontein
- Kromdraai
- Swartkrans
- Coopers A B
- Bolt's Farm
- Haasgat
- Gondolin
- Gladysvale
- Plover's Lake
- Malapa
- Rising Star

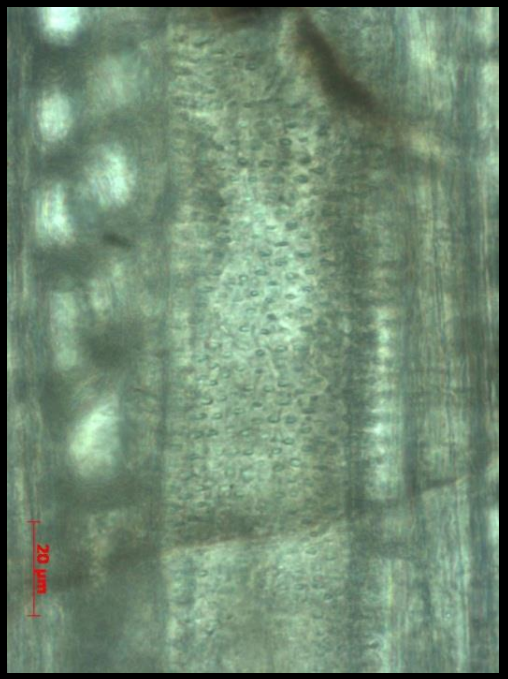




Sterkfontein fossil woods

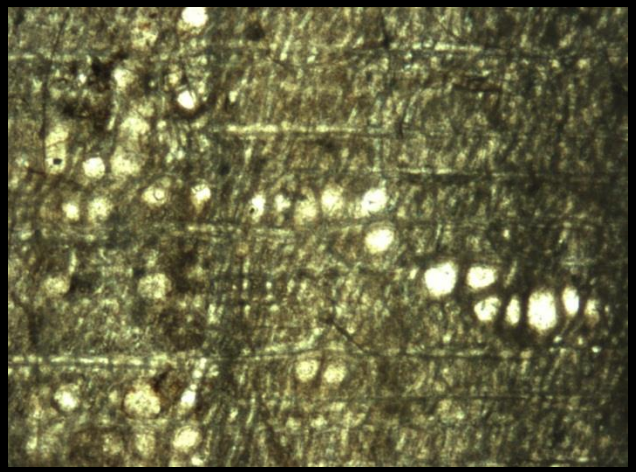




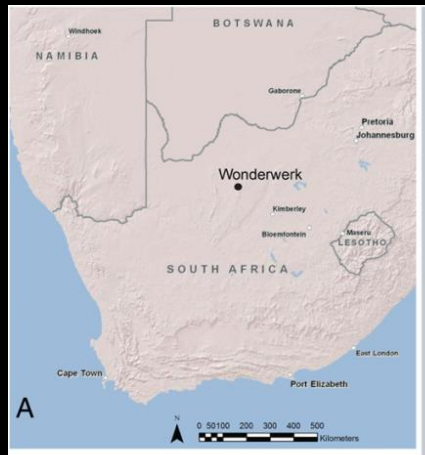


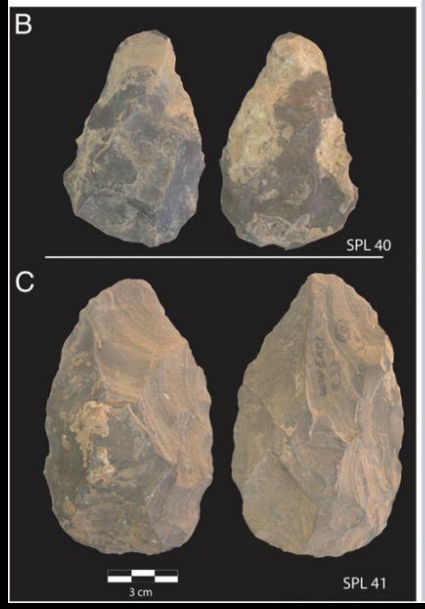
Dichapetalum mombuttense; Anastrabe intergerrima

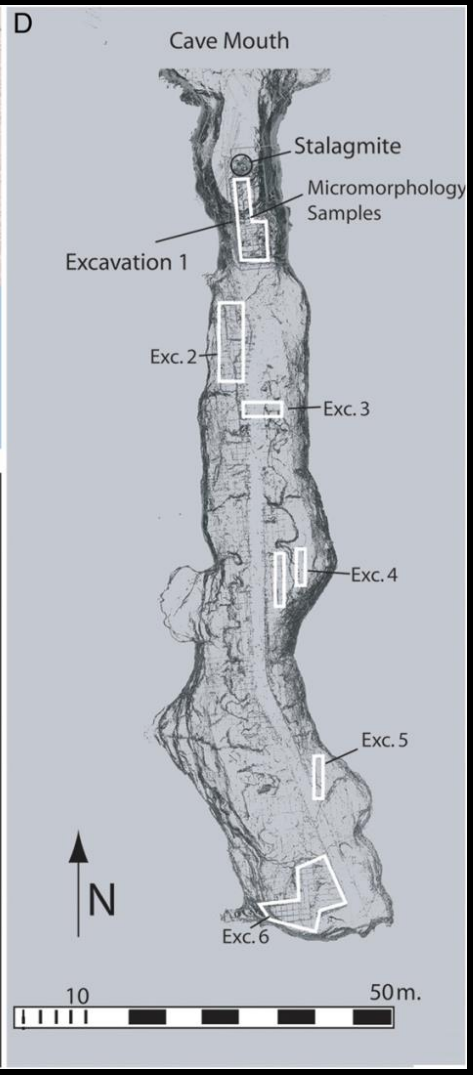
Sterkfontein Mbr 4



Wonderwerk Cave (2Ma – 0Ma)















Excavation 1 (near entrance)

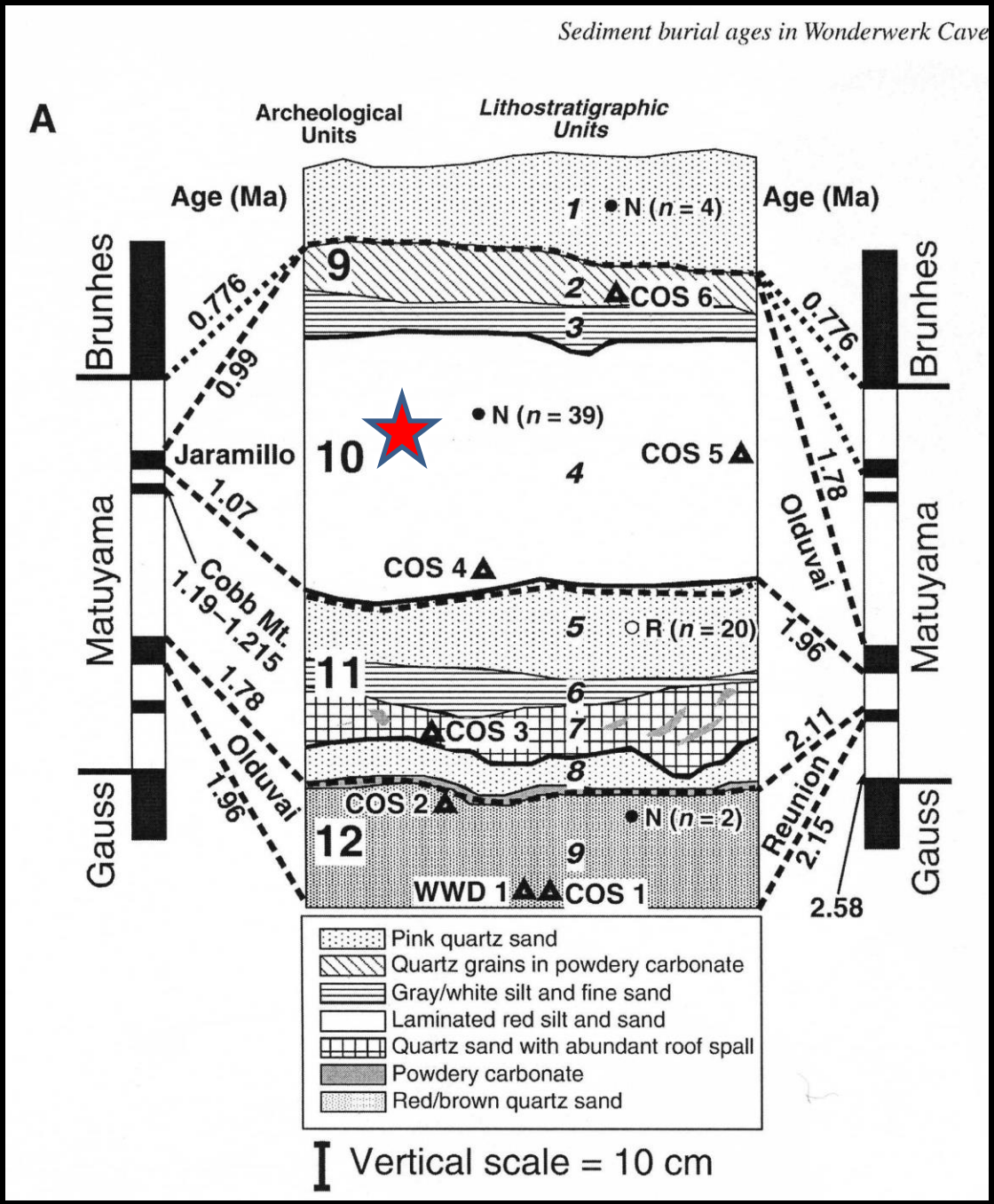


Peter Beaumont ca 1970-1990

Michael Chazan, Liora Horwitz

Wonderwerk Cave, Northern Cape
Excavation 1.

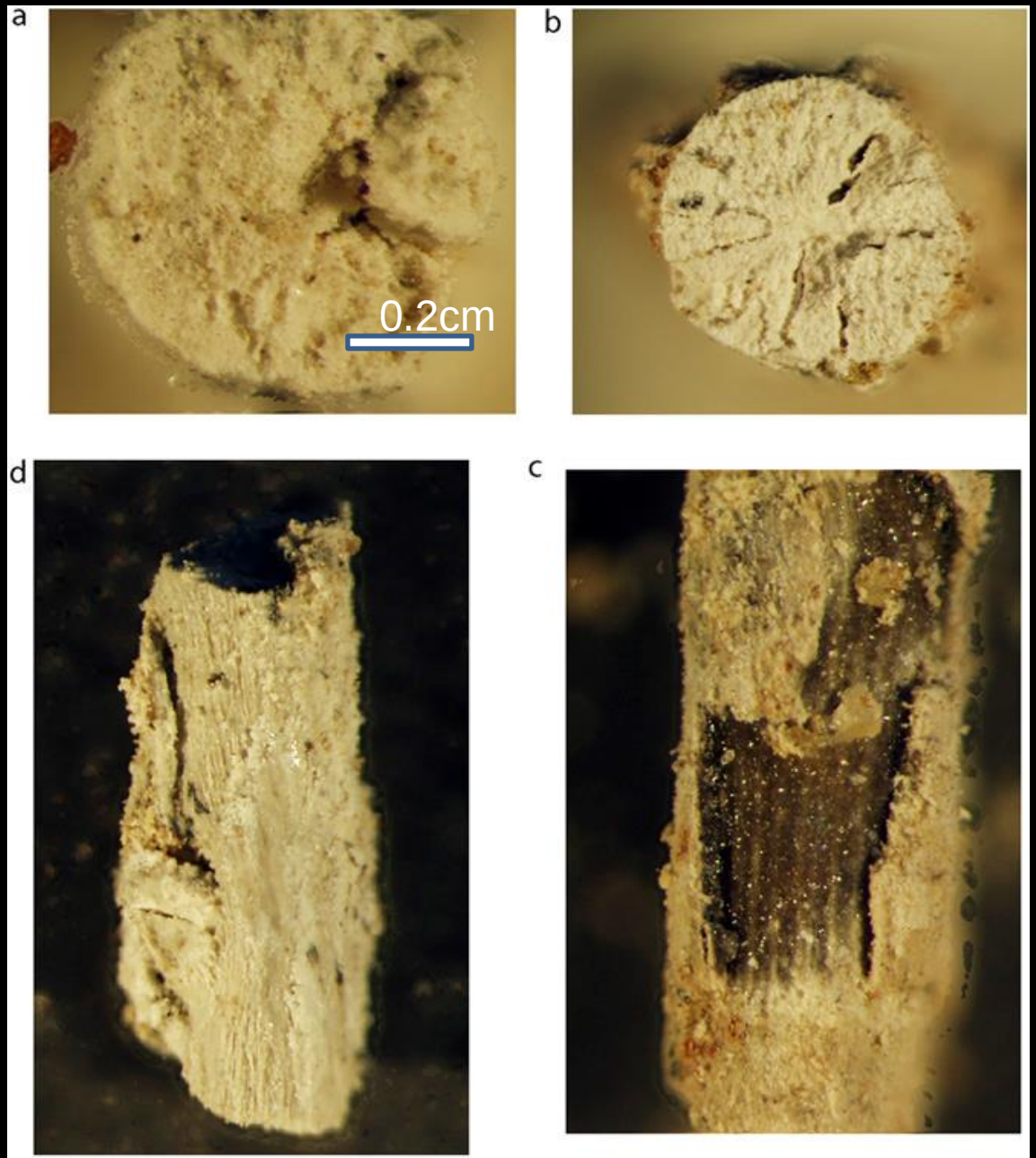
1. Good dating
2. Microstratigraphy



Chazan et al 2011

5. Burned plant fragments - fuel

Sedge



Dicot wood

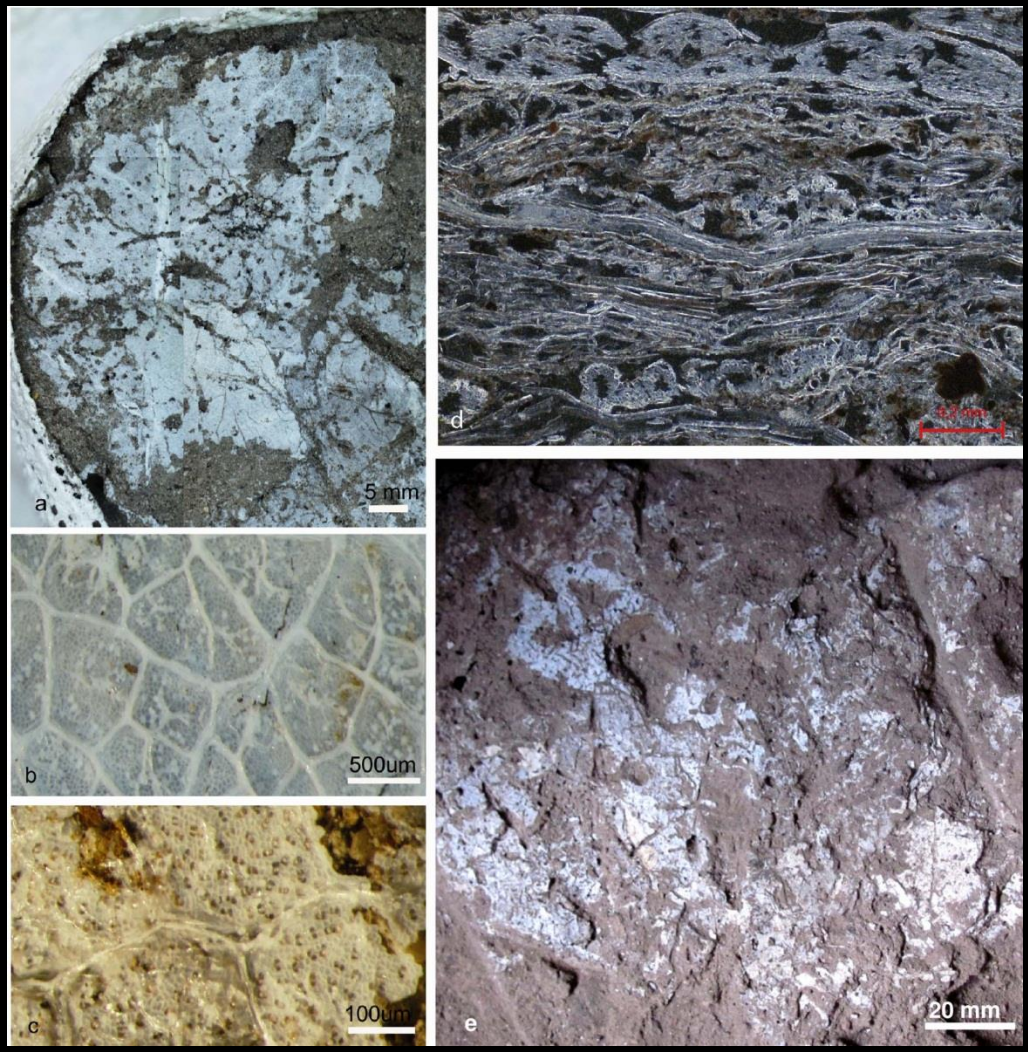
Oldest evidence of the controlled use of fire at Wonderwerk:

- Older examples exist of use of fire BUT Wonderwerk has:
- 1. Good dating: 1Mya
- 2. Microstratigraphic context
- 3. Burned bone
- 4. Burned stone
- 5. Plant fragments
- Inspire other further research

Berna et al., 2012, PNAS.

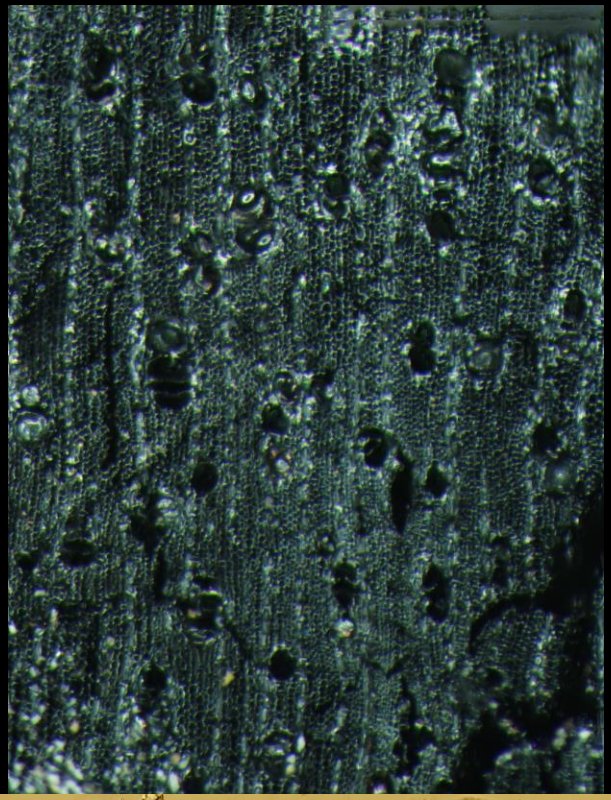


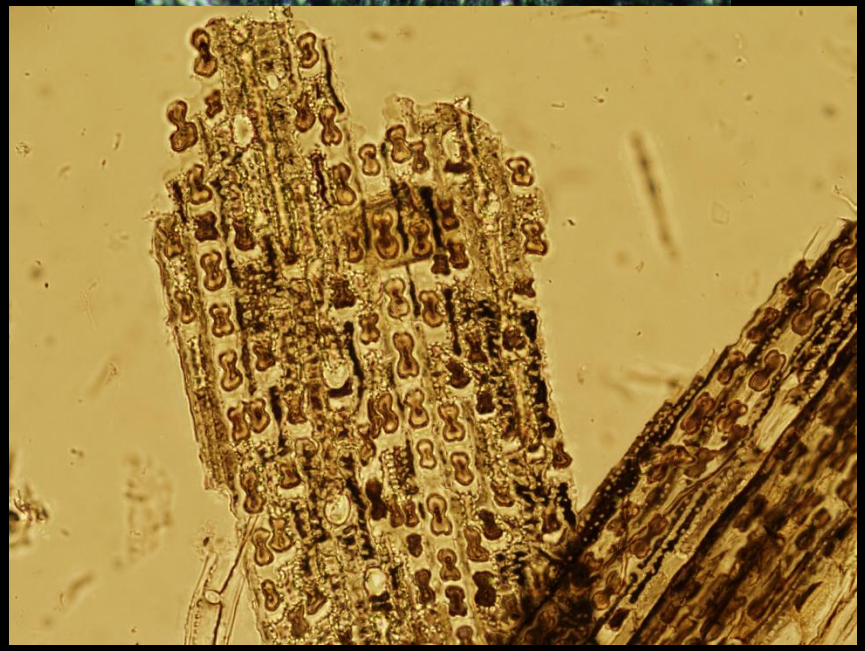
Sibudu rockshelter and medicinal plants



Wadley et al., 2011, Science,
77 000 years ago

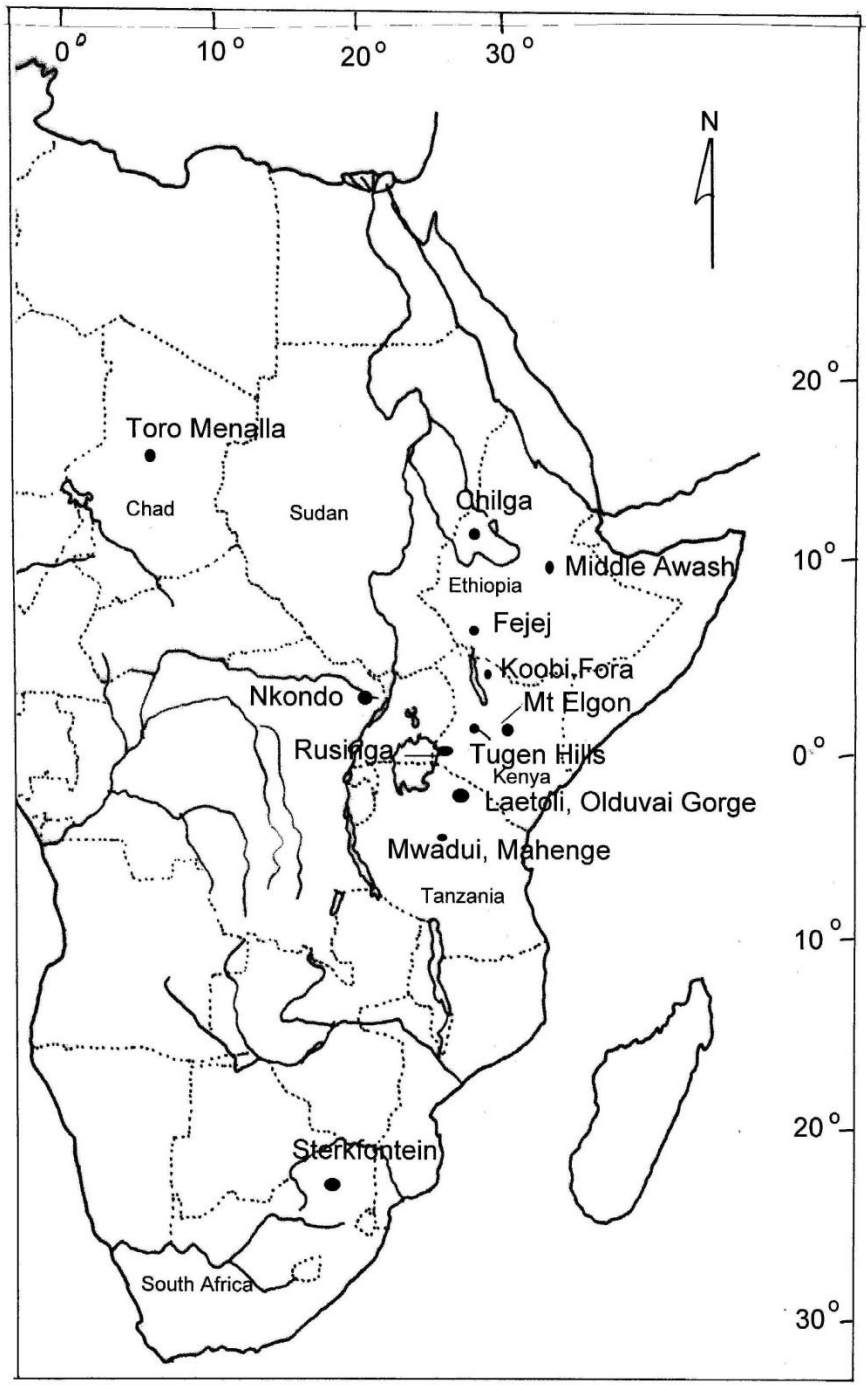
Cryptocarya woodii (Lauraceae)





Research at Sibudu Rock Shelter KZN

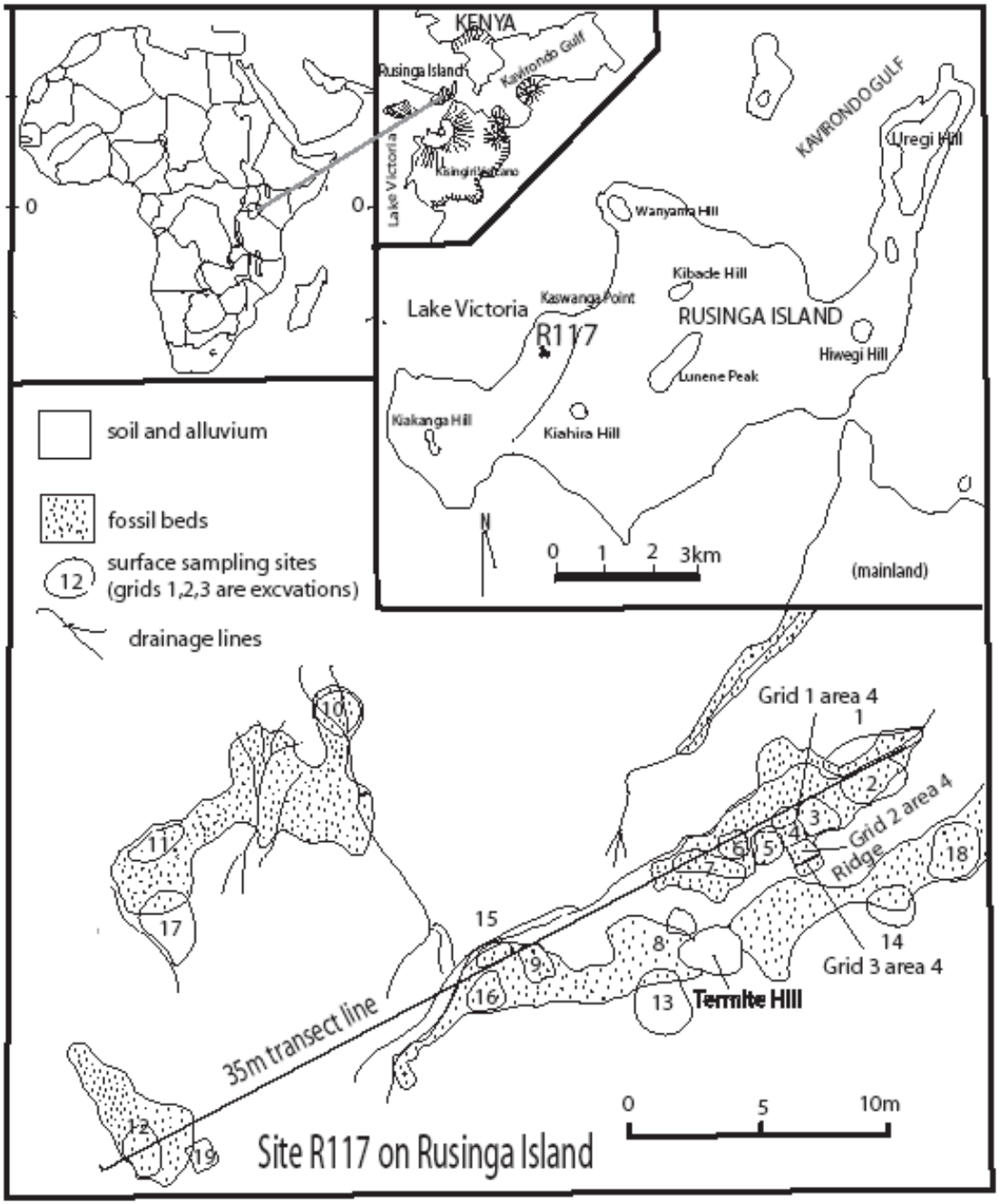
- MSA artefacts; fauna
- Charcoal
- Medicinal plants
- PhD student: Sandy Lennox
- *Spirostachys africana, Tarchonanthus camphoratus*
- Phytoliths
- Modern reference material
- PhD student: May Murungi



EAST AFRICA

Miocene - Pleistocene

Early Miocene (18Ma) Rusinga Island, Kenya



Fauna, hominoids
Seed endocasts
Leaf impessions

Collinson, Andrews, Bamford, 2009. JHE



Rusinga Island – Early Miocene



Rusinga Island: Kaswanga Point – Hiwegi Formation

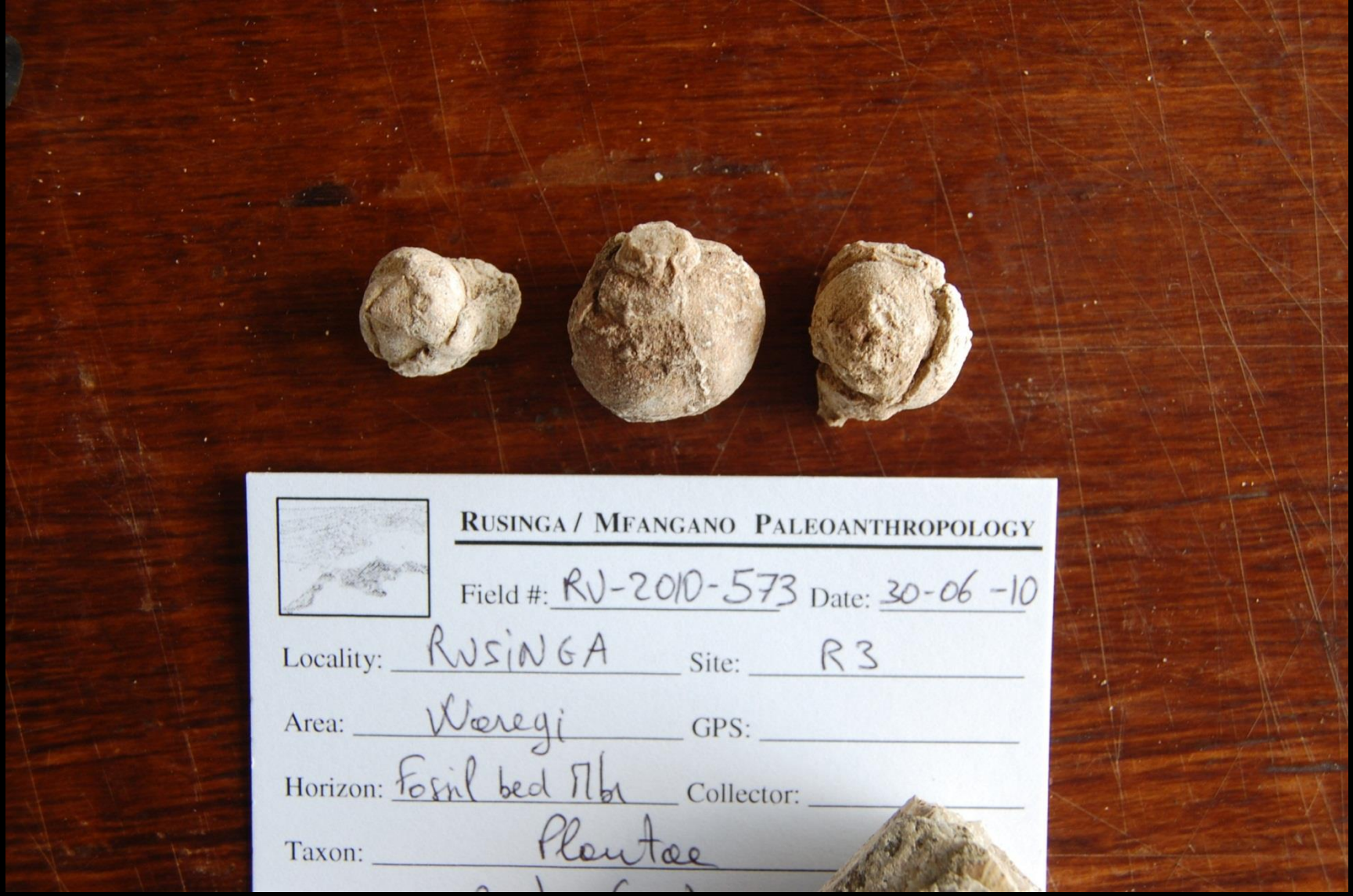


Rusinga Island leaves



Maxbauer et al. 2013. Pal. elect

Climate from leaf physiognomy

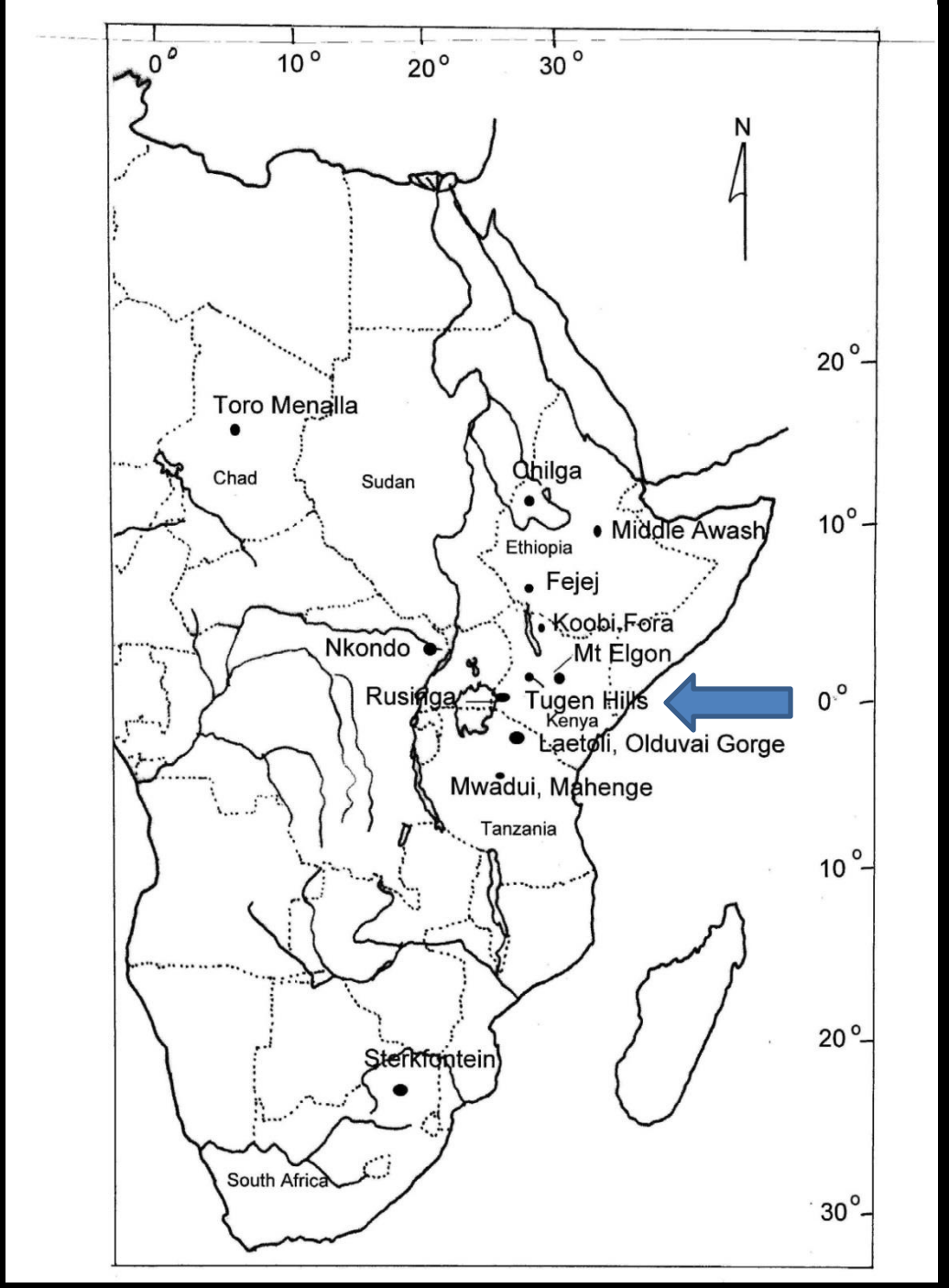


Seed endocasts – Nearest Living Relative – reconstruct vegetation and climate

Late Miocene, Tugen Hills, Kenya: Lukeino

Early hominin: *Orrorin tugenensis*

Other sites with macroflora





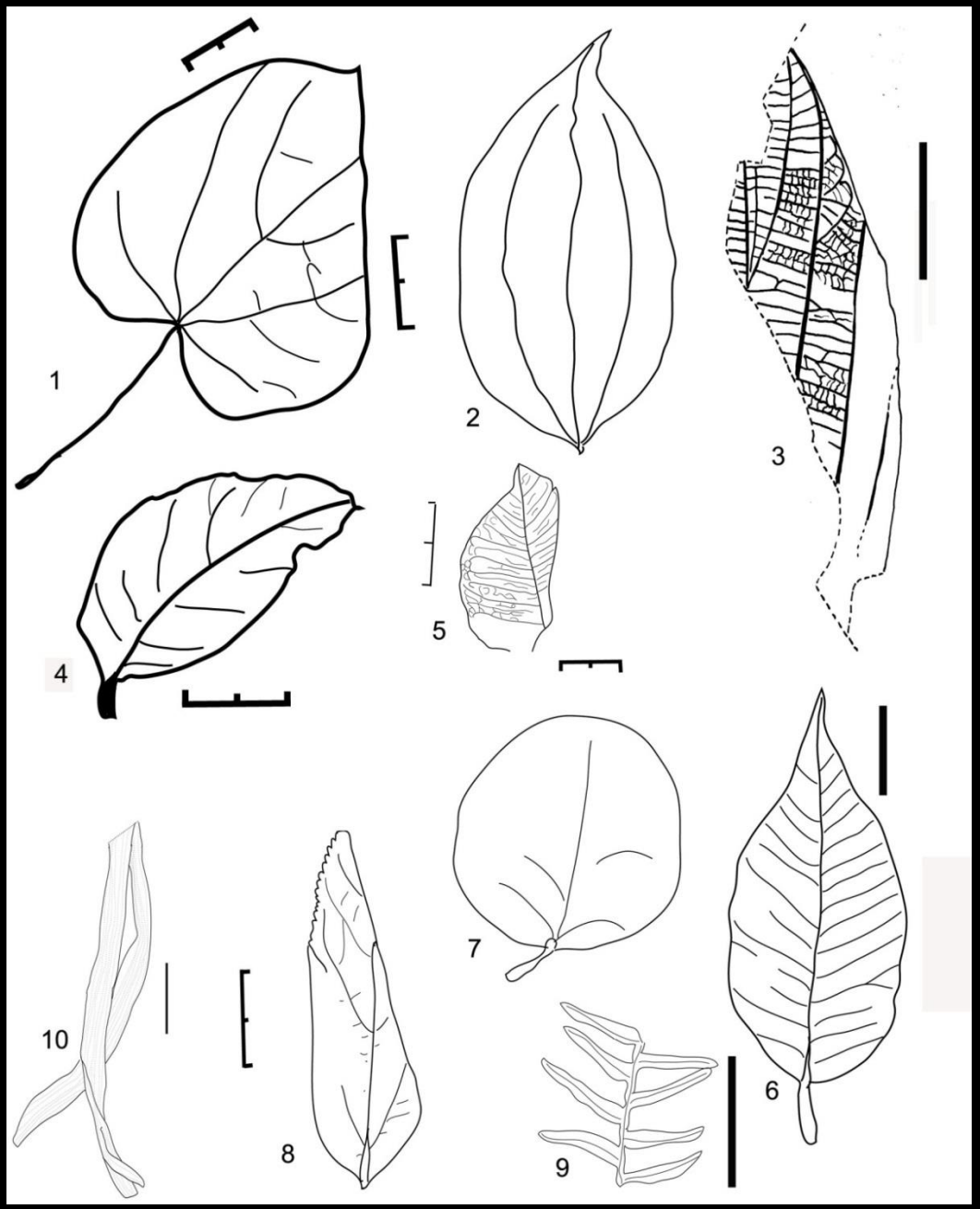
Lukeino Fm; Kapcharar site



Leaves (all sites)

Leaf features

Leaf shape
Leaf area
Venation
Apex shape
Base shape
Margin – teeth & type
Margin – entire
etc



CLAMP results from Kapcharar

- Altitude c. 2000m; Latitude 0° 50’N
- Rainfall:
  - MAP: 1723 mm
  - Length of growing season: 10.6 months
  - MMGSP = 173 mm
  - Dry months total = 227 mm
  - Relative humidity = 76%

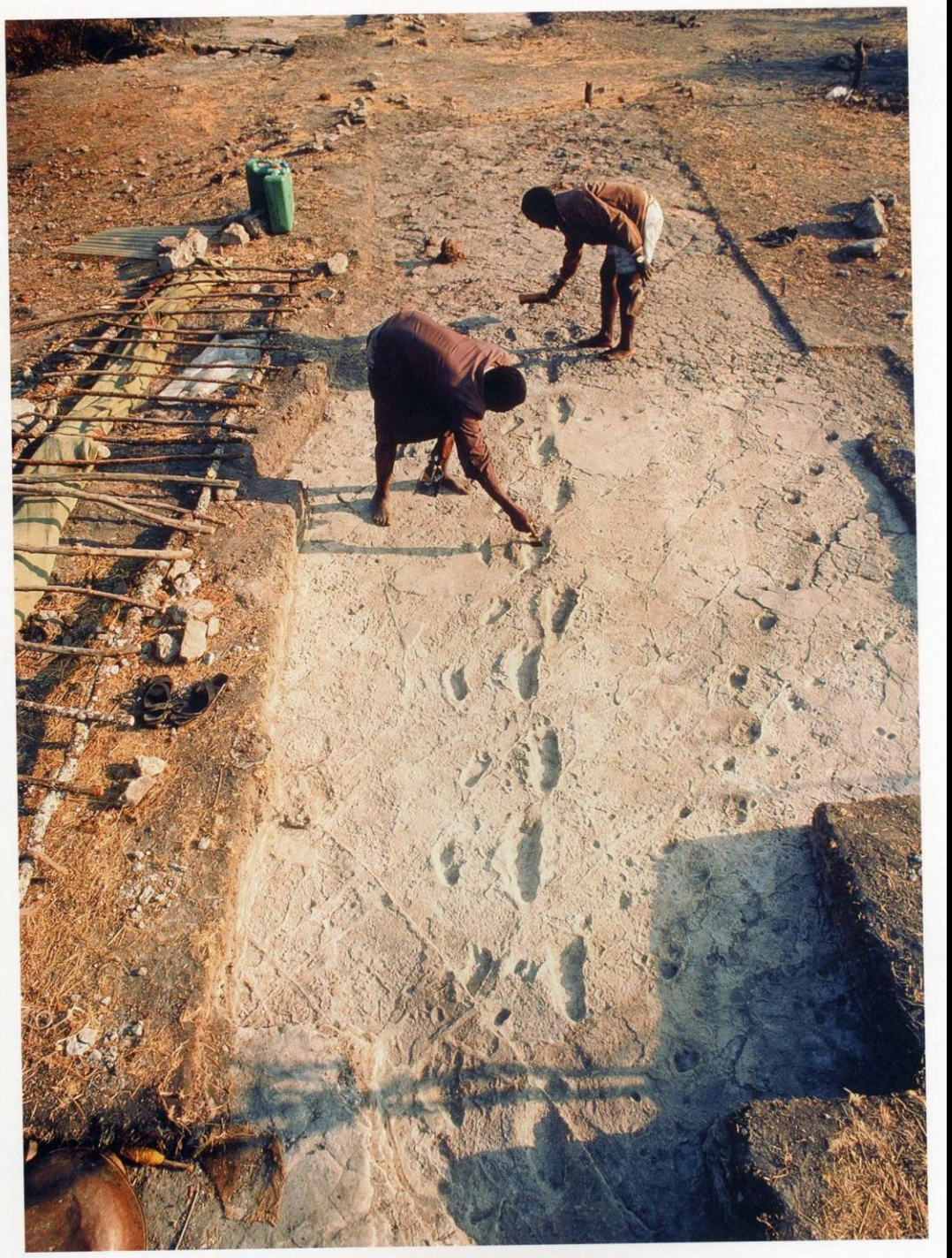
- Temperature:
  - MAT: 19.8° C
  - WMMT: 25.4° C
  - CMMT: 14.3° C

  - Deciduous forest or woodlar
  - with open areas nearby



Bamford et al., 2013, Geobios

Footprints at Laetoli



Summary of projects: Upper Laetolil Beds, Laetoli, Tanzania

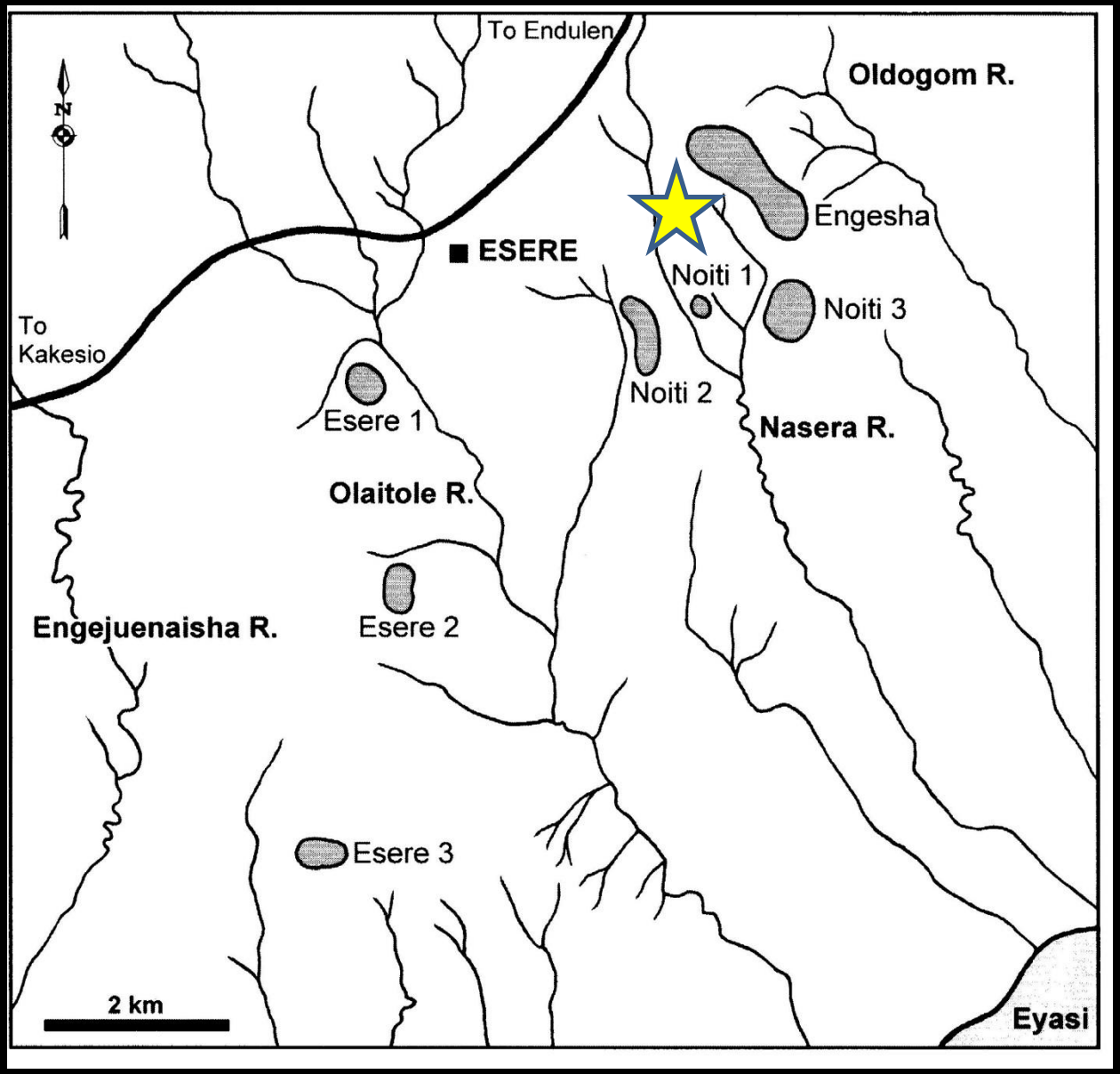
Features

- Hominin footprints
- *Australopithecus afarensis*
- Diverse fauna
- Palaeoenvironment
  - Riverine setting, no lake
  - Mosaic woodland

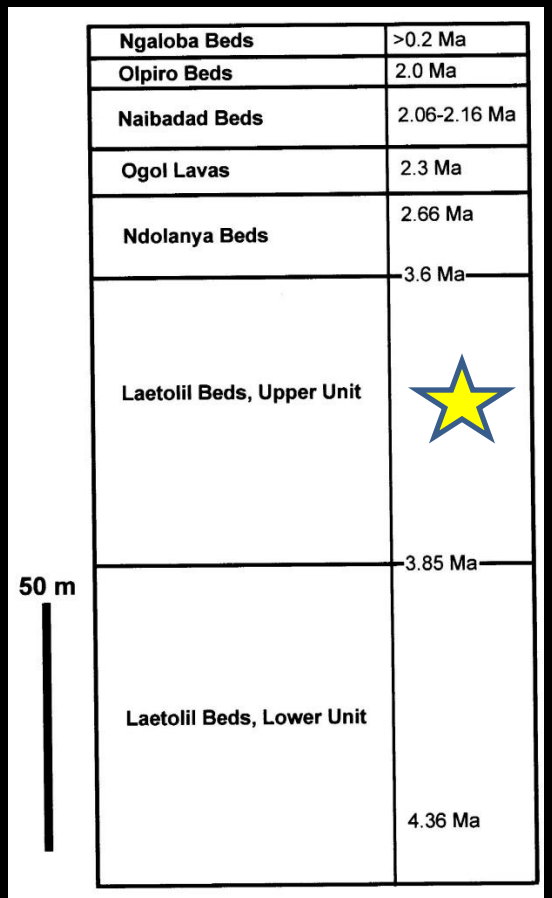
Projects

- Landscape palaeoecology project (Terry Harrison)
- Modern vegetation mapping (Peter Andrews)

- NEW palaeoecology project (TZ: Magori, Mabulla, Muciba)
  - Footprint level
  - Flora, fauna
  - Isotopes



Terry Harrison, NYU



Pliocene Laetoli, Tanzania



Laetoli, Noiti 1 – fossil wood site



Laetoli seeds

Laetoli leaves





Vegetation reconstruction from fossil woods

- Fossil plants
- Upper Laetolil beds (ca 3.85 – 3.6 Ma)
- Families: common African
- Vegetation: forest, evergreen woodland, dry woodland, riverine and wooded grassland
- Warm to hot climate
- Lahar
- Phytoliths: grass short cell morphotypes





Mapping of modern vegetation - thicket

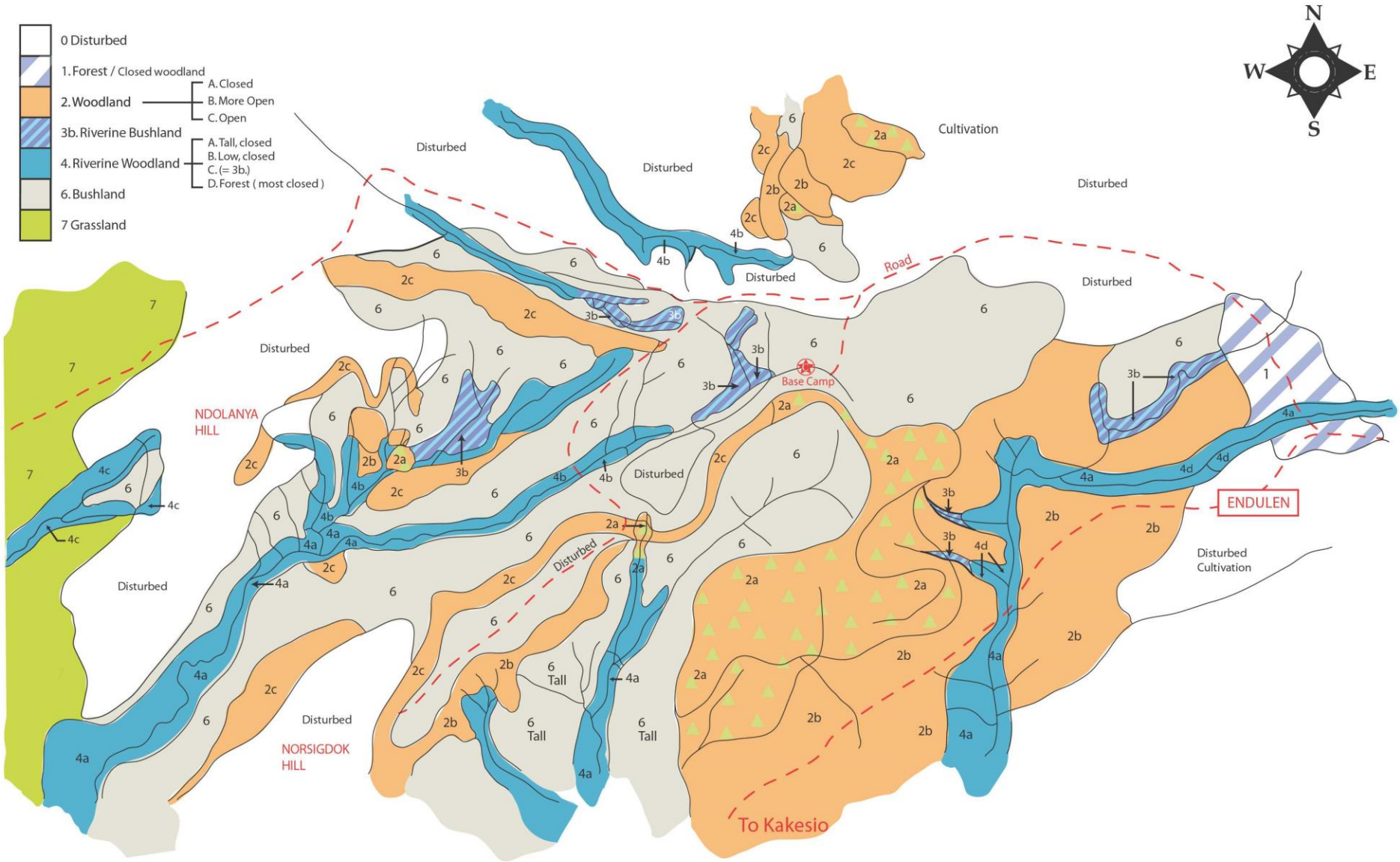


Laetoli, grass on mbuga

7 Vegetation types recognised: eg

Vegetation unit 2: Deciduous woodland (4 subunits)

Canopy	*Combretum spp. Albizia spp. Dombeya spp.*
Lower canopy	*Rhus natalensis, Acacia seyal, Grewia similis, Carissa edulis, Gymnosporium spp.*
Ground cover	*Hypoestes verticillaris, Tinnia aethiopica, Indigofera spicatum, Solanum nigrum, Lippia ukambense*
Liana	*Pterolobium stellatum*
More open areas	*Ziziphus mucronata, Acacia drepanolobium, Balanites aegyptiaca, Cordia ovalis, Maerua triphylla, Euphorbia candelabrum*
Dry well drained hillsides	*Commiphora spp., Terminalia brownii, Azanza garckeana, Sclerocarya birrea, Gardenia latea*



Laetoli Site. Tanzania

Vegetation Map

Predictions for changing climate:

Increased rainfall

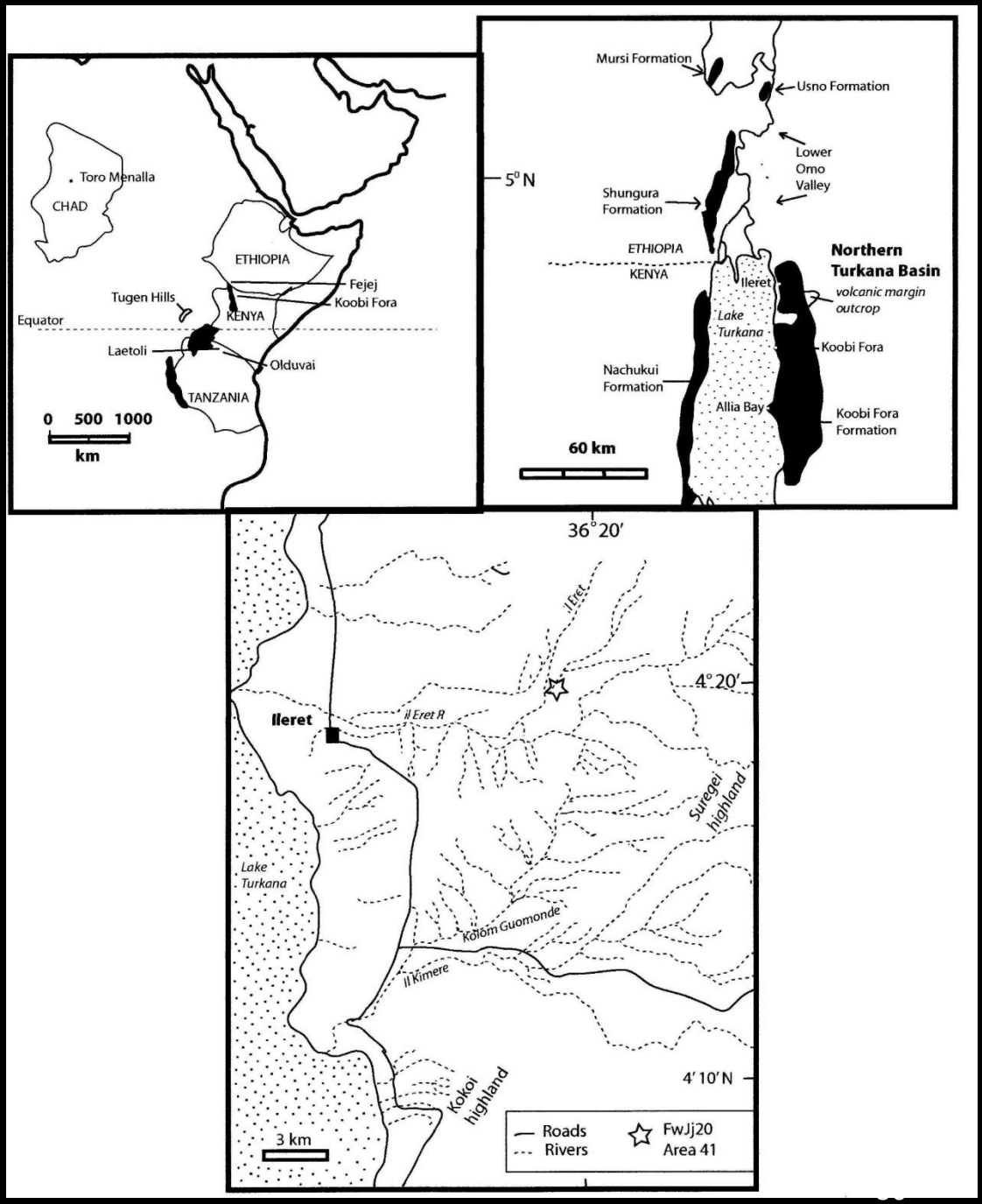
- Increased canopy height on well-drained soils
- Decreased tree cover on poorly drained soils
- Increase in *Acacia* species; increase in species diversity along rivers

Decreased rainfall

- Increase in height, density, species richness on water-logged soils
- Species change on well-drained soils: drier species, more open vegetation
- Riverine woodland species would shift downstream

Koobi Fora, East Lake Turkana, Kenya

Fluvial and lacustrine deposits, tuffs
Stone artefacts, fauna, fossil woods





Koobi Fora and teaching palaeoecology



Ileret River and gallery forest



Fossil wood from Okote Member, FwJj14



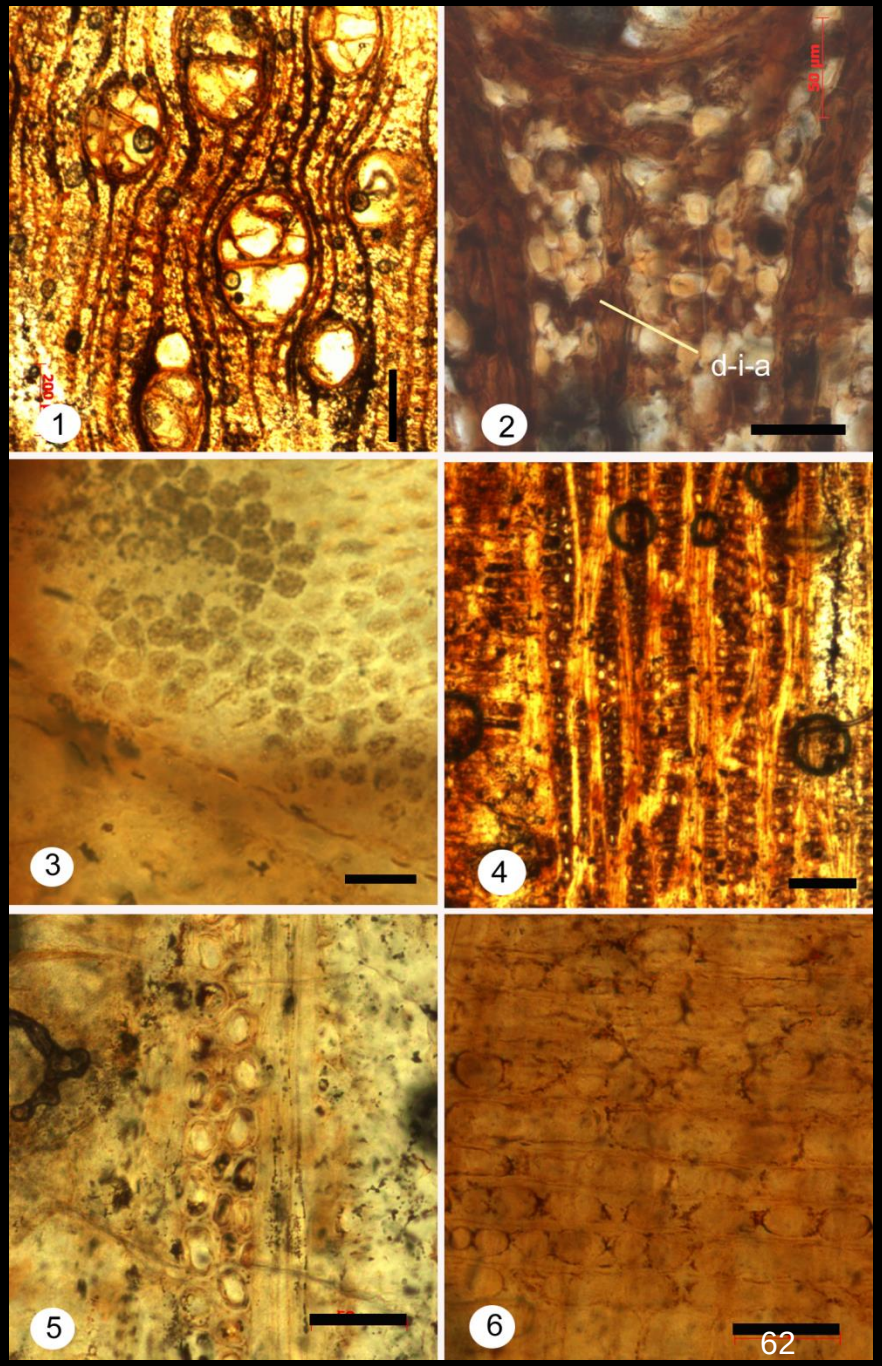
Lake Turkana - today



Site FxJj20, Area 41; upper Burgi Member

Apocynaceae
Funtumia sp.
KF009

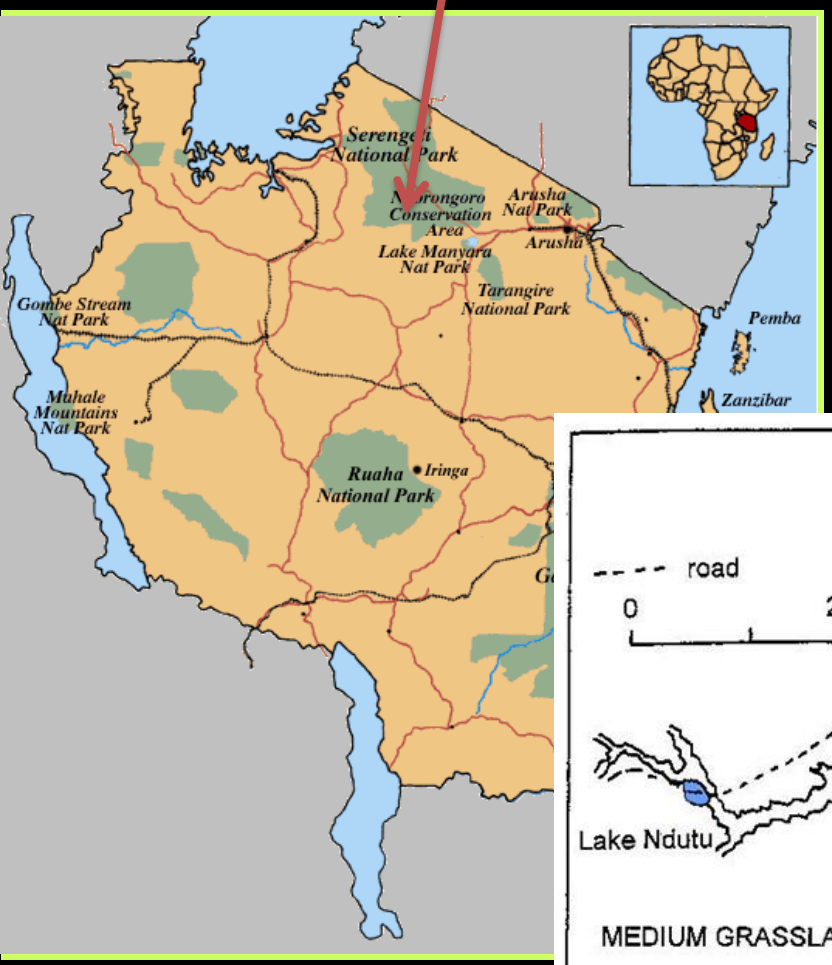
indicates groundwater forest
butchery site of mammals, fish, crocodiles



Braun et al., 2010, PNAS

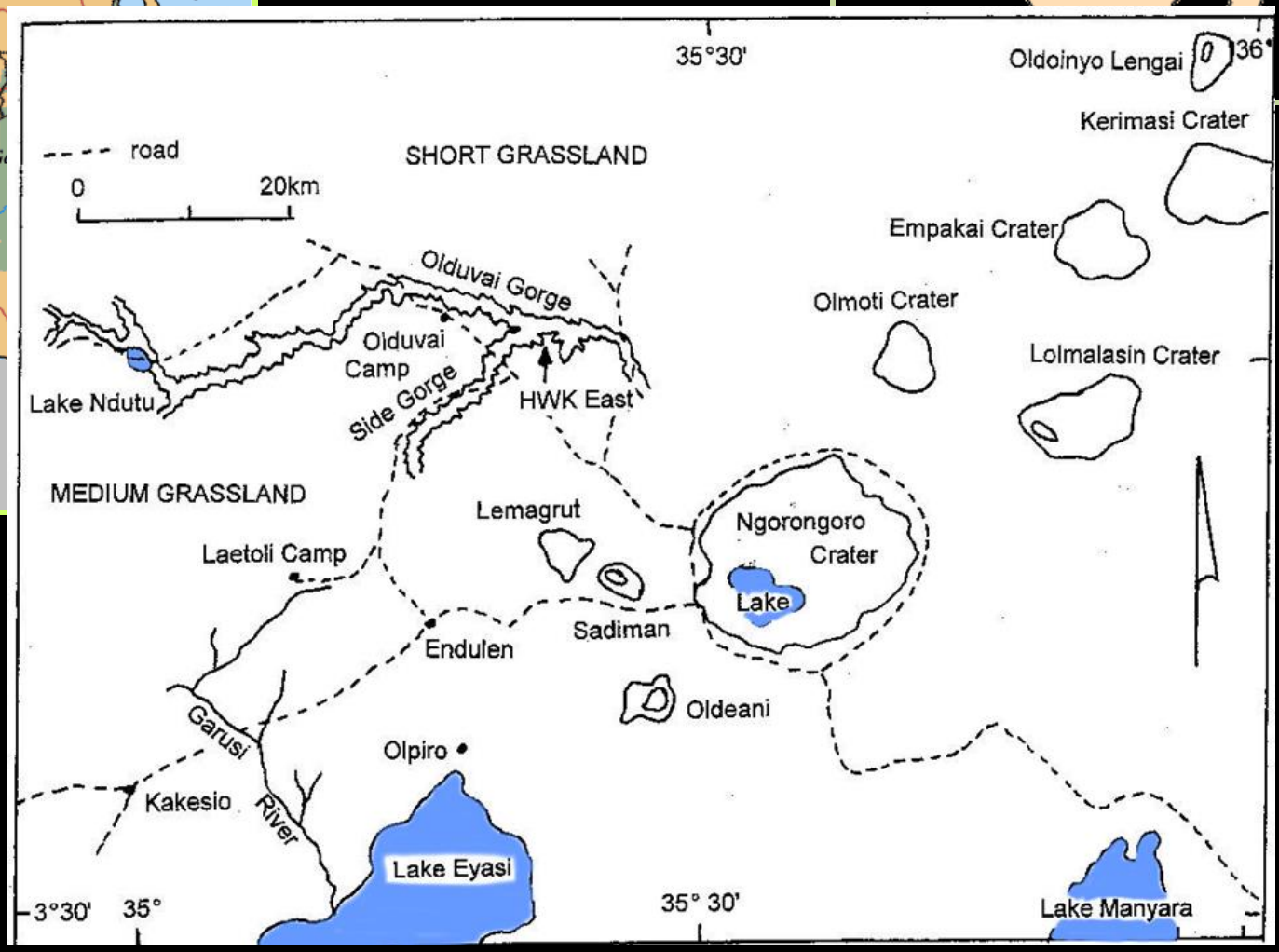
Northern Kenya, Eastern Lake Turkana

- Koobi Fora Formation
- Upper Burgi Member (2.2 – 1.89 Ma)
- Locality FxJj 20
- Archaeological site with earliest evidence of stone artefacts associated with large mammal resource exploitation
- Clear understanding of manufacturing techniques
- Fauna - >250 terrestrial species
- Associated fossil woods





Olduvai Gorge





Olduvai Gorge from Second Fault

Pliocene Olduvai Gorge, Tanzania

- *Zinjanthropus (Paranthropus) boisei*
- Mary Leakey 1959
- *Homo habilis* …….
- Oldowan stone tool technology

- Olduvai Landscape Palaeoanthropology Project 1987+
- Discovery driven AND inductive mode
- 1. Model of landscape ecology
- 2. Build predictive models for fauna/hominins on the landscape
- 3. Testing and refining the models

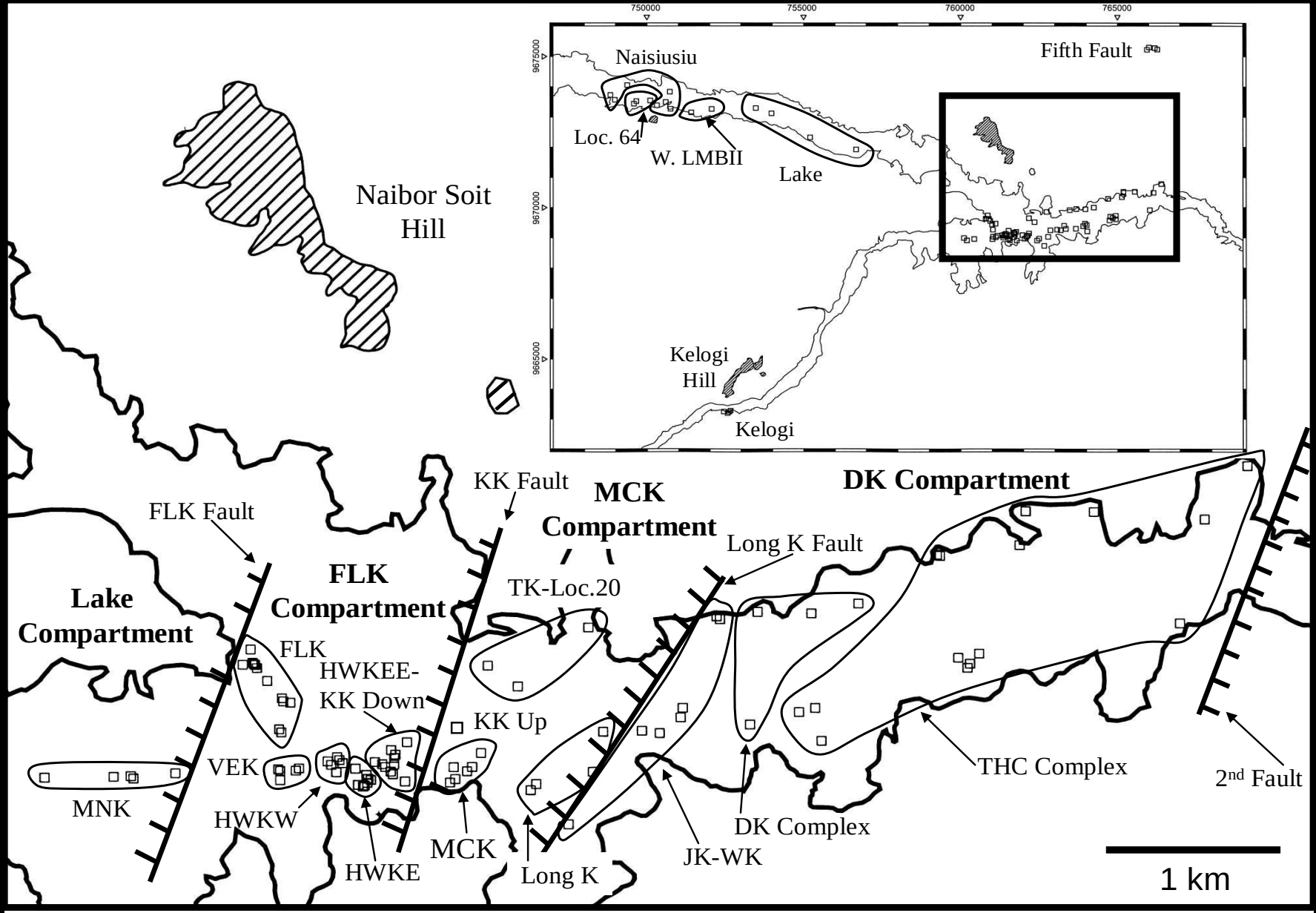
- i.e NOT simply discovery driven



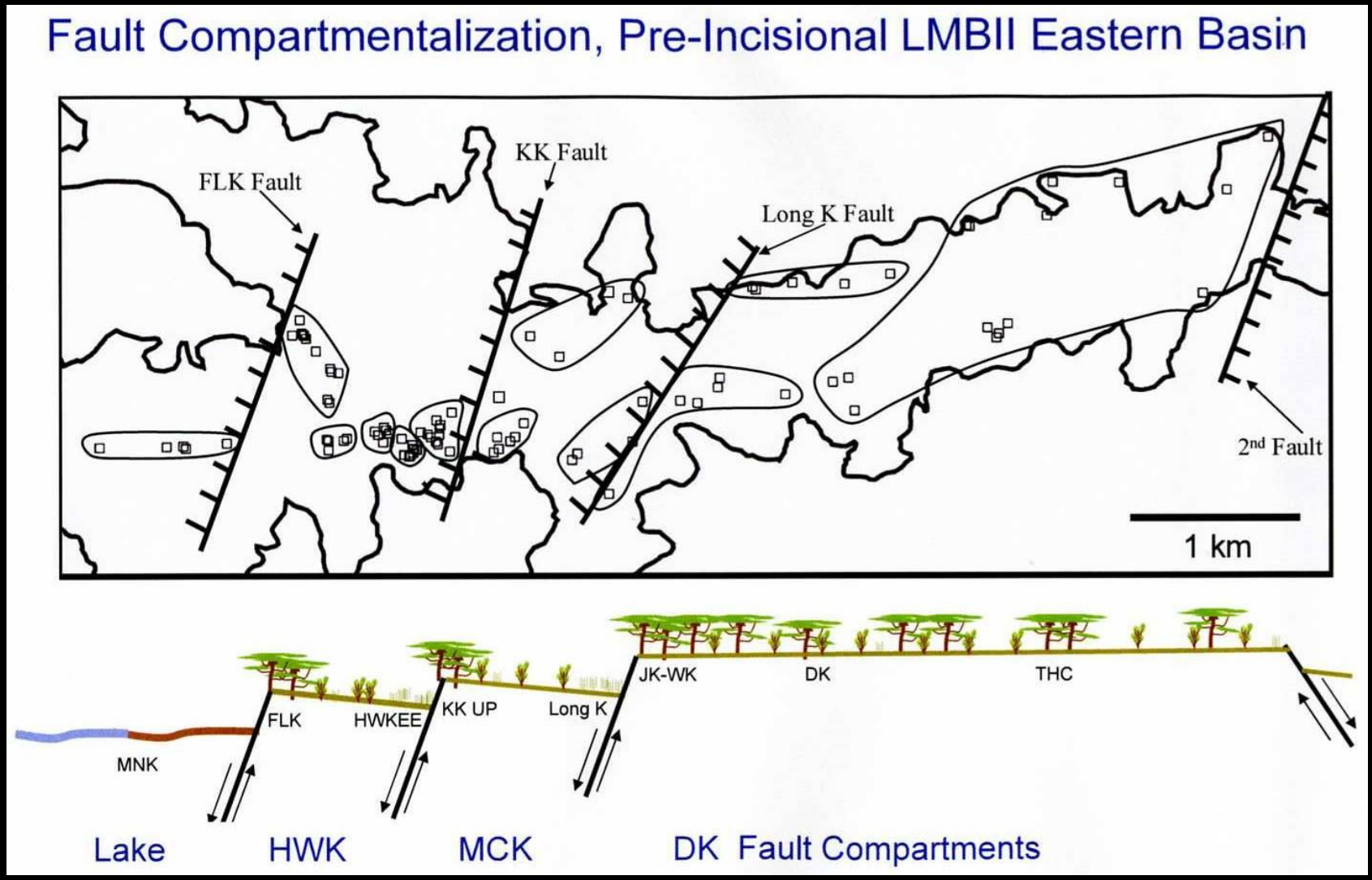




OLAPP –
1. model of landscape ecology
(hazards and affordances)



OLAPP – 2 Build a predictive model (topography, water, food locations)



(topography, water, food locations)





OLAPP – 3. Test and refine the model

(geotrenches, concentrations/types of lithics, bones, plants)







Materials and Methods



a. Observation,
b. Site selection
c. Reference collection



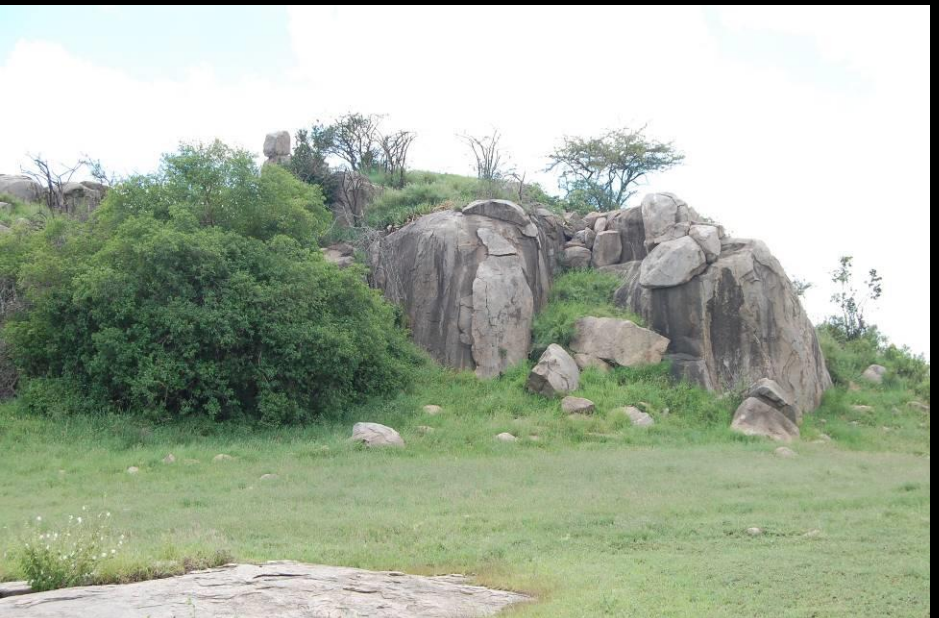


Ngorongoro Crater: Ngoitokitok forest-marsh transition

Serengeti







- Open woodlands
- Riverine woodlands
- Open grasslands
- Kopjies

Lake Manyara









Okavango Delta







Seekoeivlei Nature Reserve







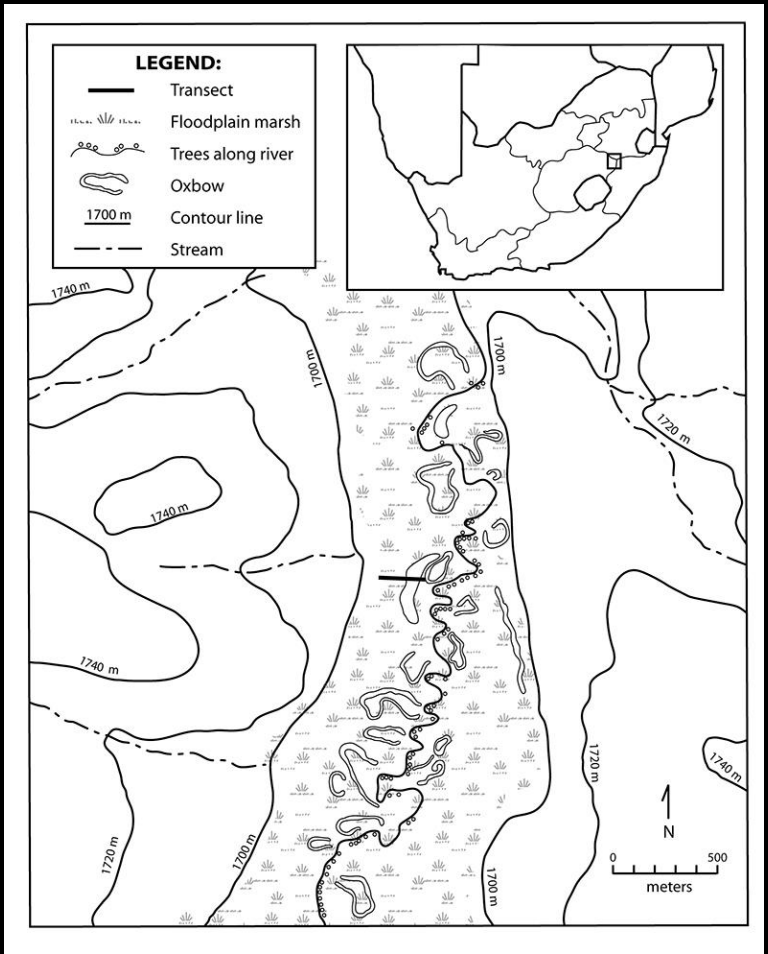
High altitude

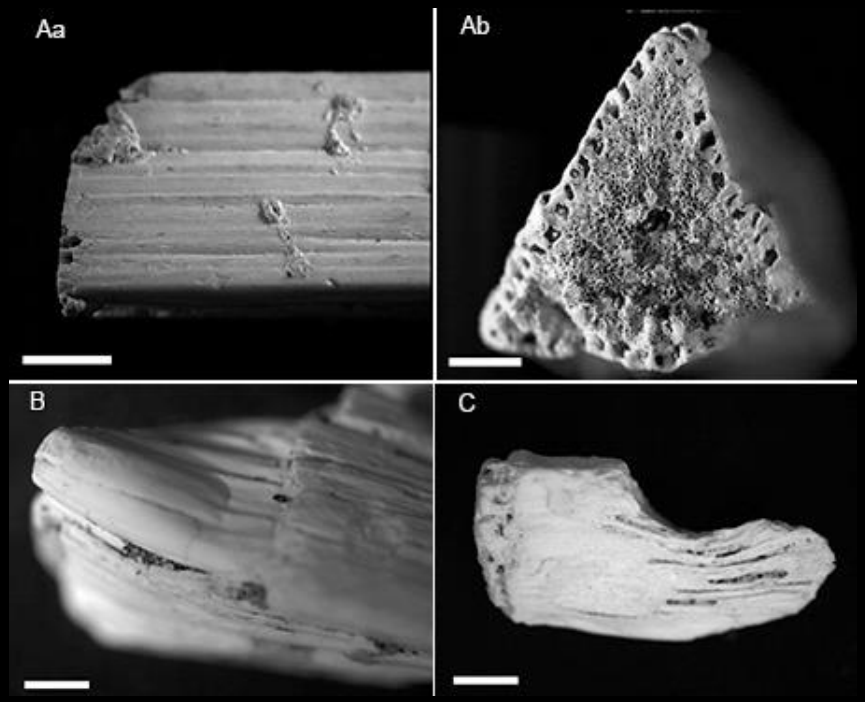
Fresh water

Mixed grasses and sedges

Large mammals

Seekoeivlei wetland taphonomy





Weathering signatures;
trampling, insect damage

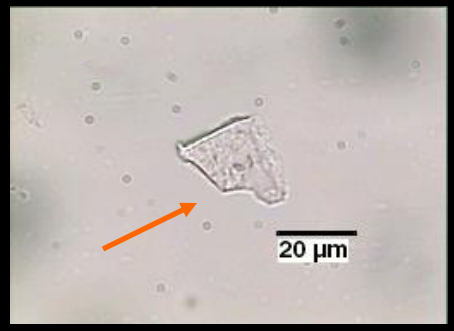






Phytoliths identified in T-107.2





Phytoliths identified in Spray paint layer















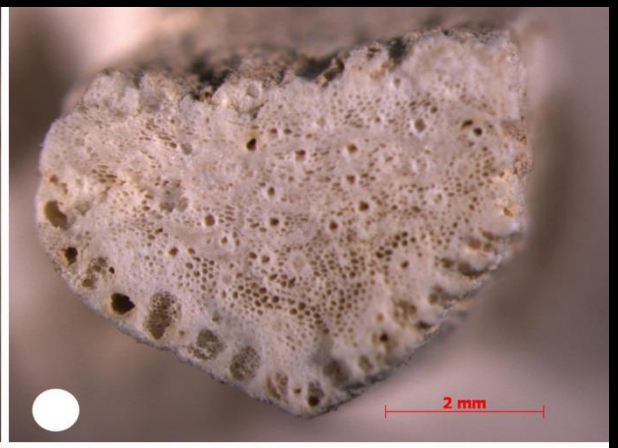
Fossil evidence

Palms

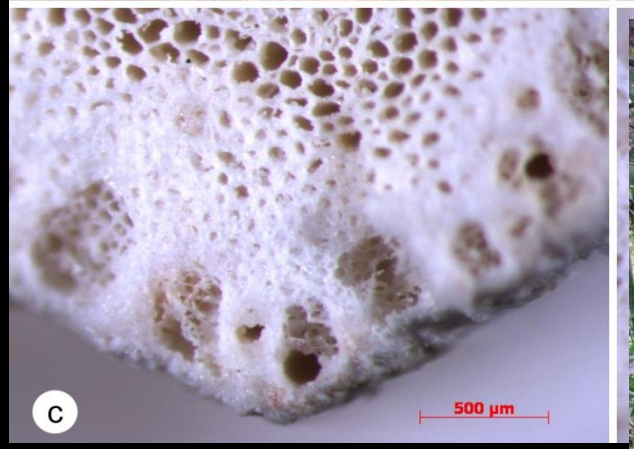








Sedge: *Cyperus sp.*



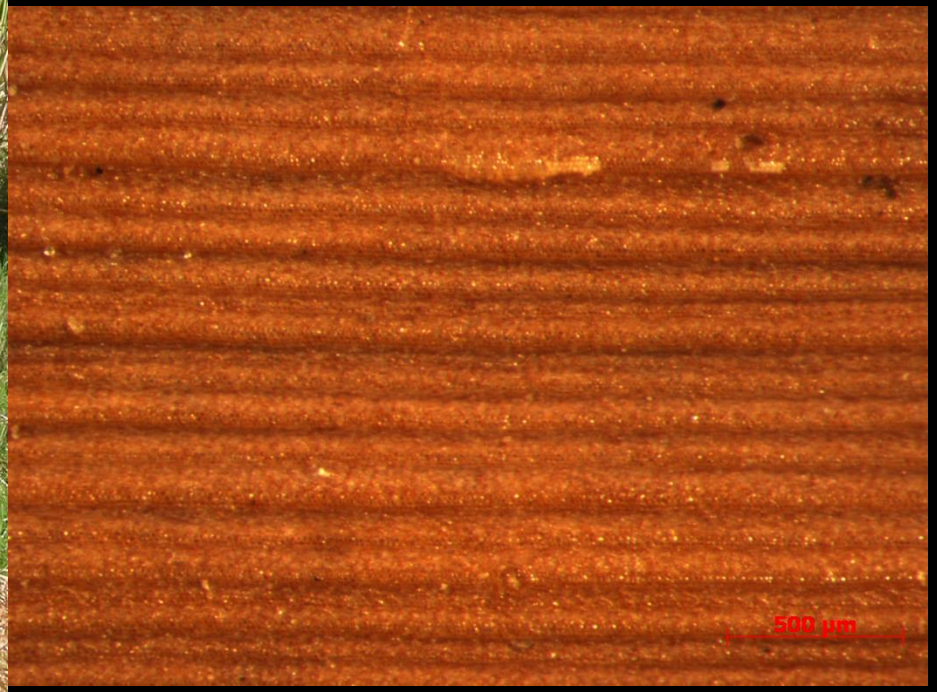




Typha sp.







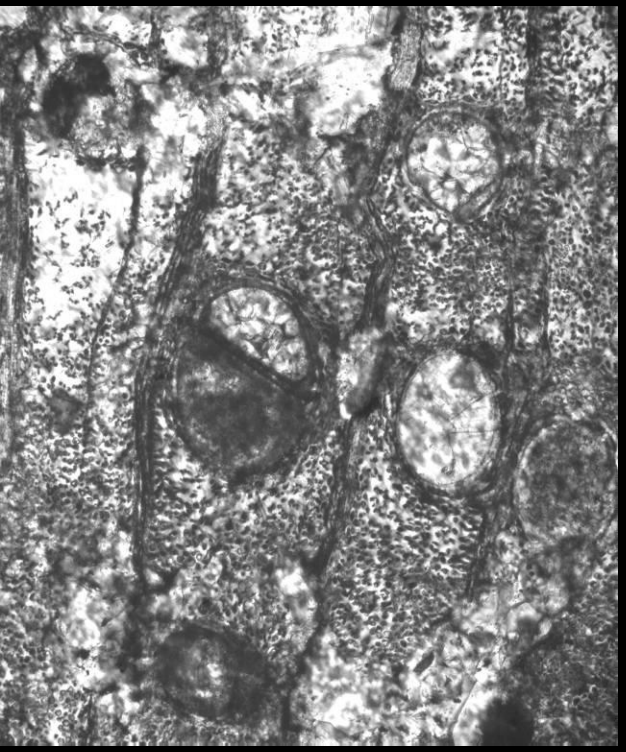
Woody twigs







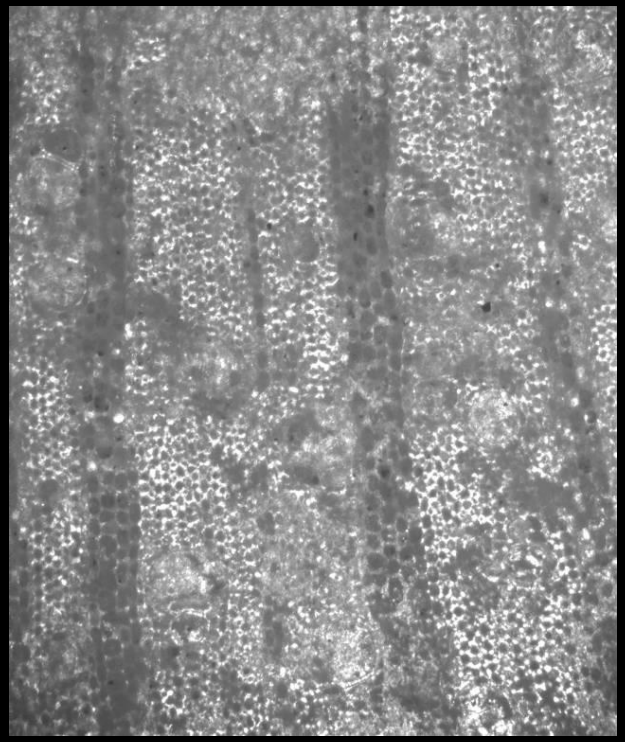
Silicified wood – *Guibourtia coleosperma*



ts



tls



Ts – unidentified dicot wood

~ LMBII, HWKE
Caesalpiniaceae
Large shady tree
Southern distribution

Bamford 2005

Grassland below Tuff IF

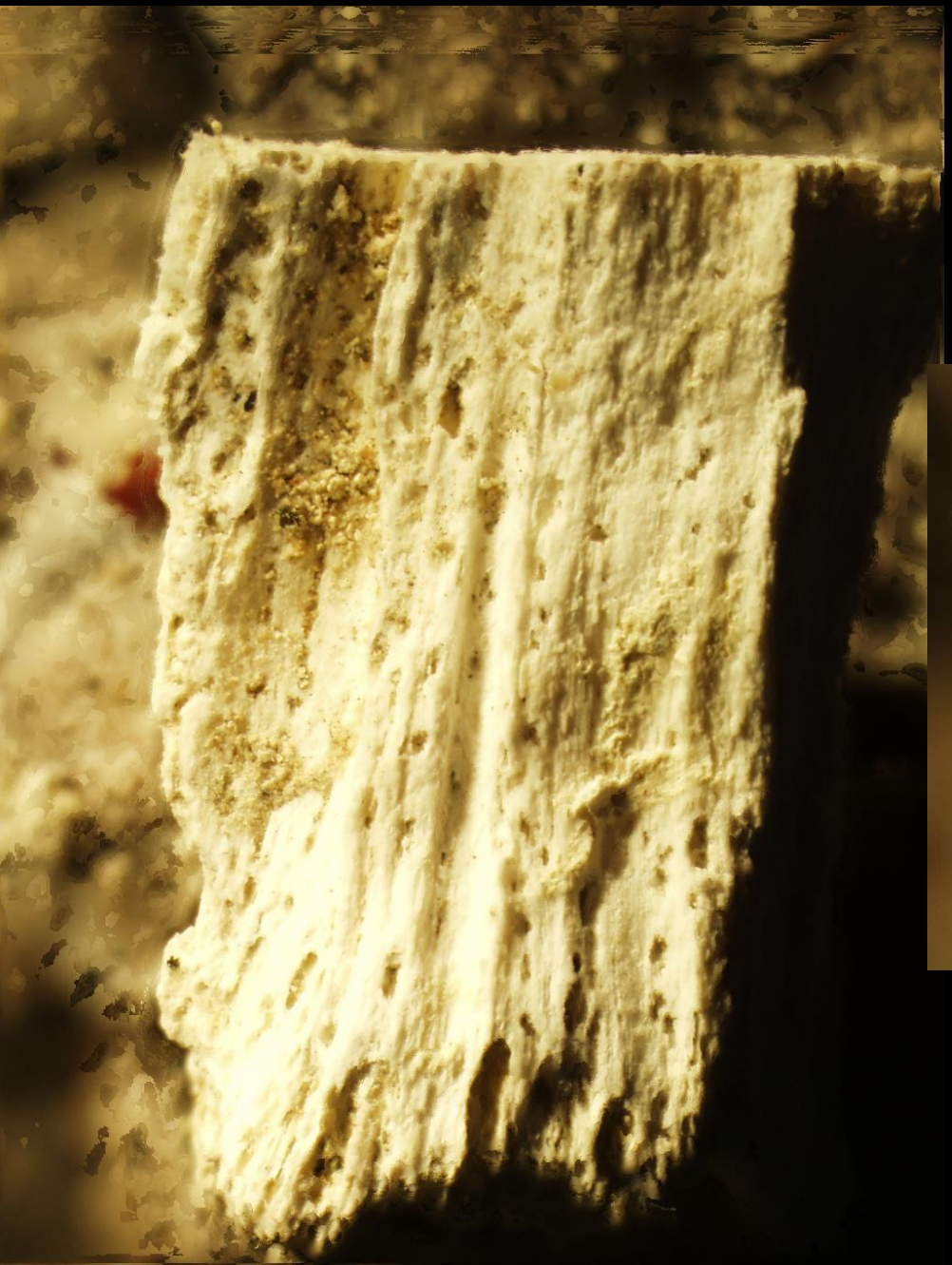


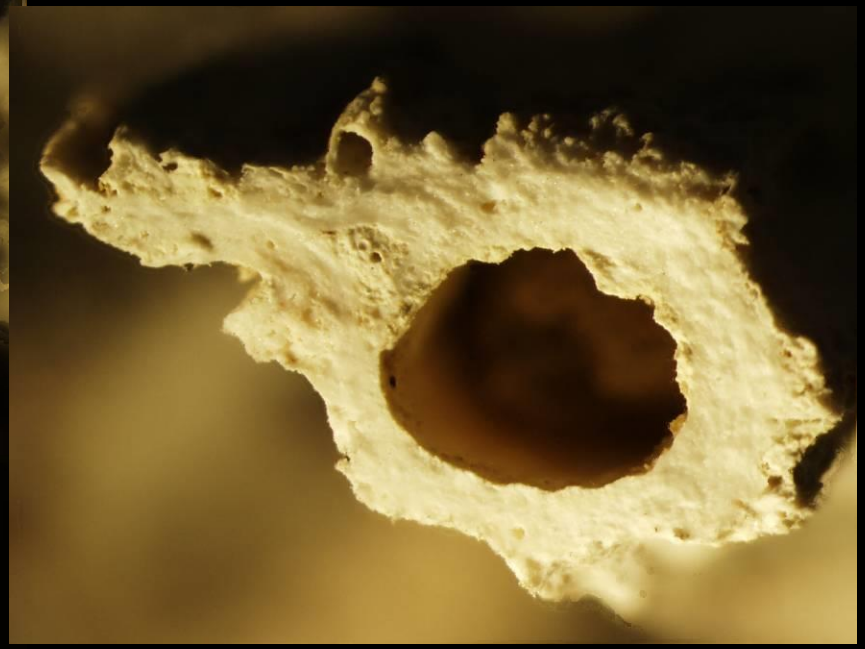


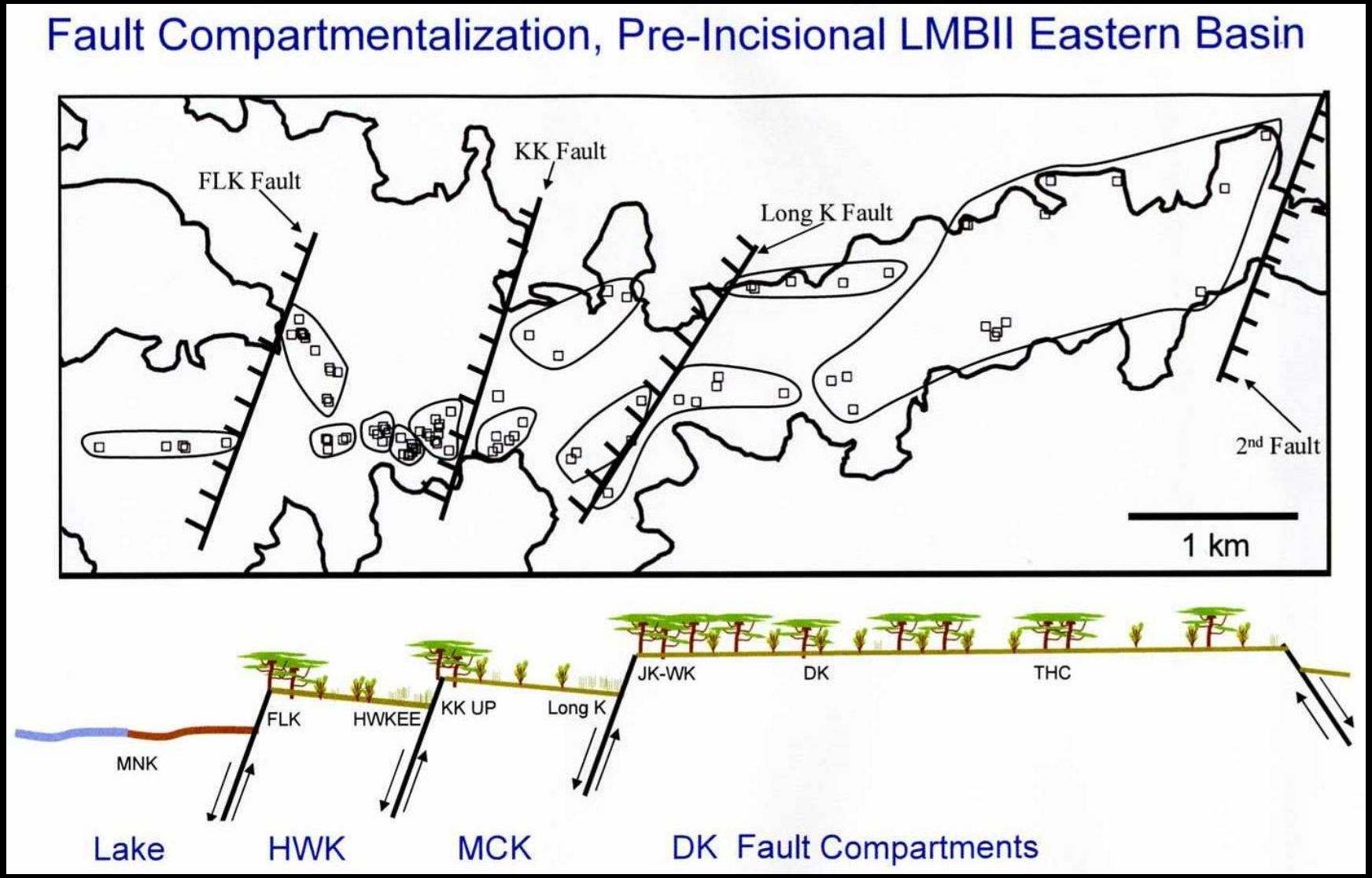
Bamford et al;, 2008

Grass culm

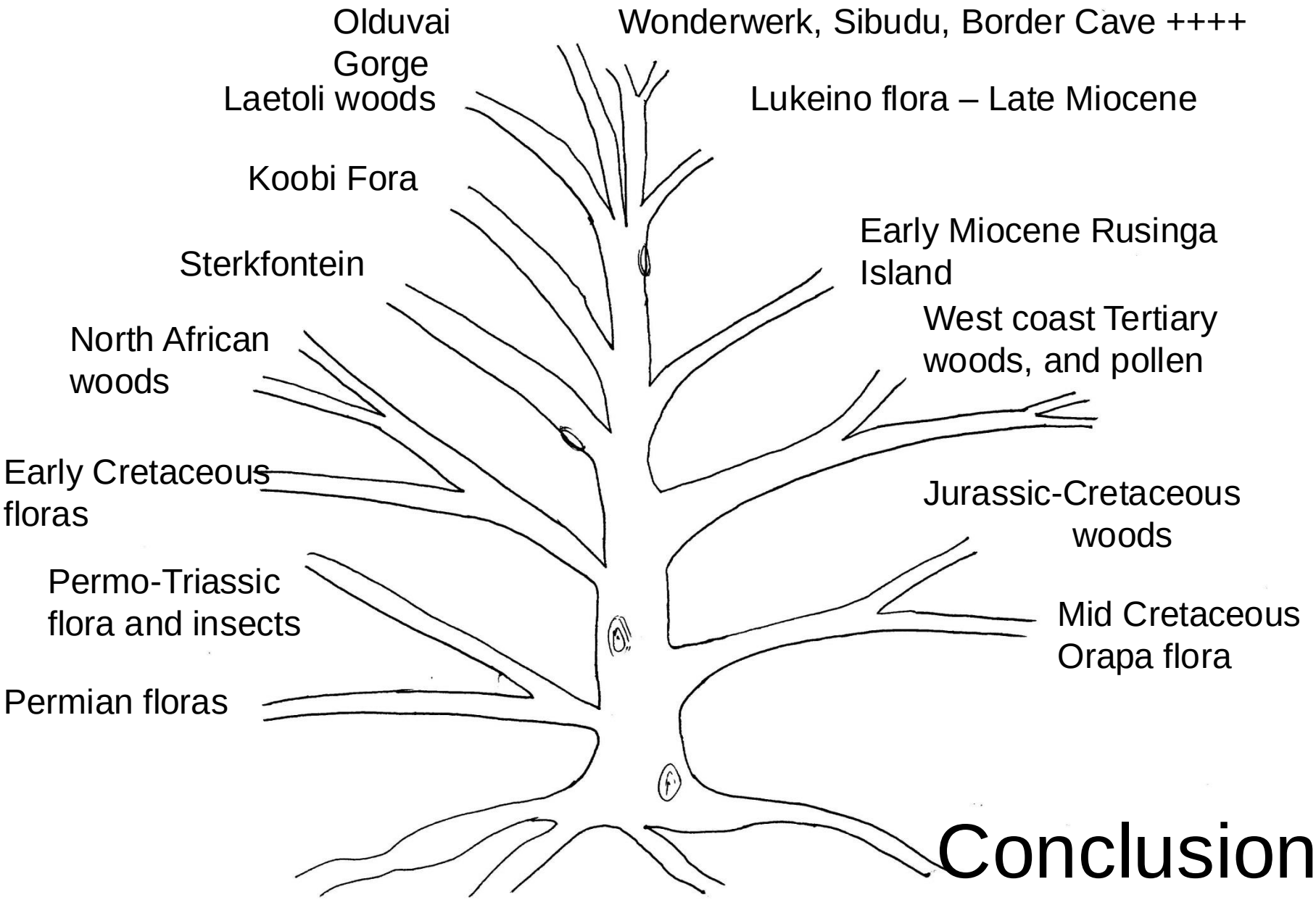
MCK: Tr 108 surf





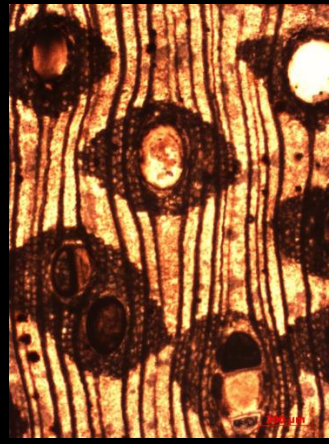


Is the model correct?


Olduvai Gorge
Wonderwerk, Sibudu, Border Cave ++++
Laetoli woods
Lukeino flora – Late Miocene
Koobi Fora
Early Miocene Rusinga Island
Sterkfontein
West coast Tertiary woods, and pollen
North African woods
Early Cretaceous floras
Jurassic-Cretaceous woods
Permo-Triassic flora and insects
Mid Cretaceous Orapa flora
Permian floras
Conclusion







Many separate projects - all related to plants
Vegetation – Palaeoenvironment – Climate

Permian
Jurassic-Cretaceous
Miocene
Plio-Pleistocene

Conclusion

African links

- Research sites
- Similar vegetation/fauna
- Student training
- Societies – SASQUA, EAQUA, WAQUA
- Workshops
- Funding networks: PAST – “Scatterlings of Africa”
- NRF, COSTECH, Leakey Foundation

Future research

- Multidisciplinary research
- Predictive models and testing
- Refined dating methods
- Improved/new methods

- Move from data collection to larger scale interpretation

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