



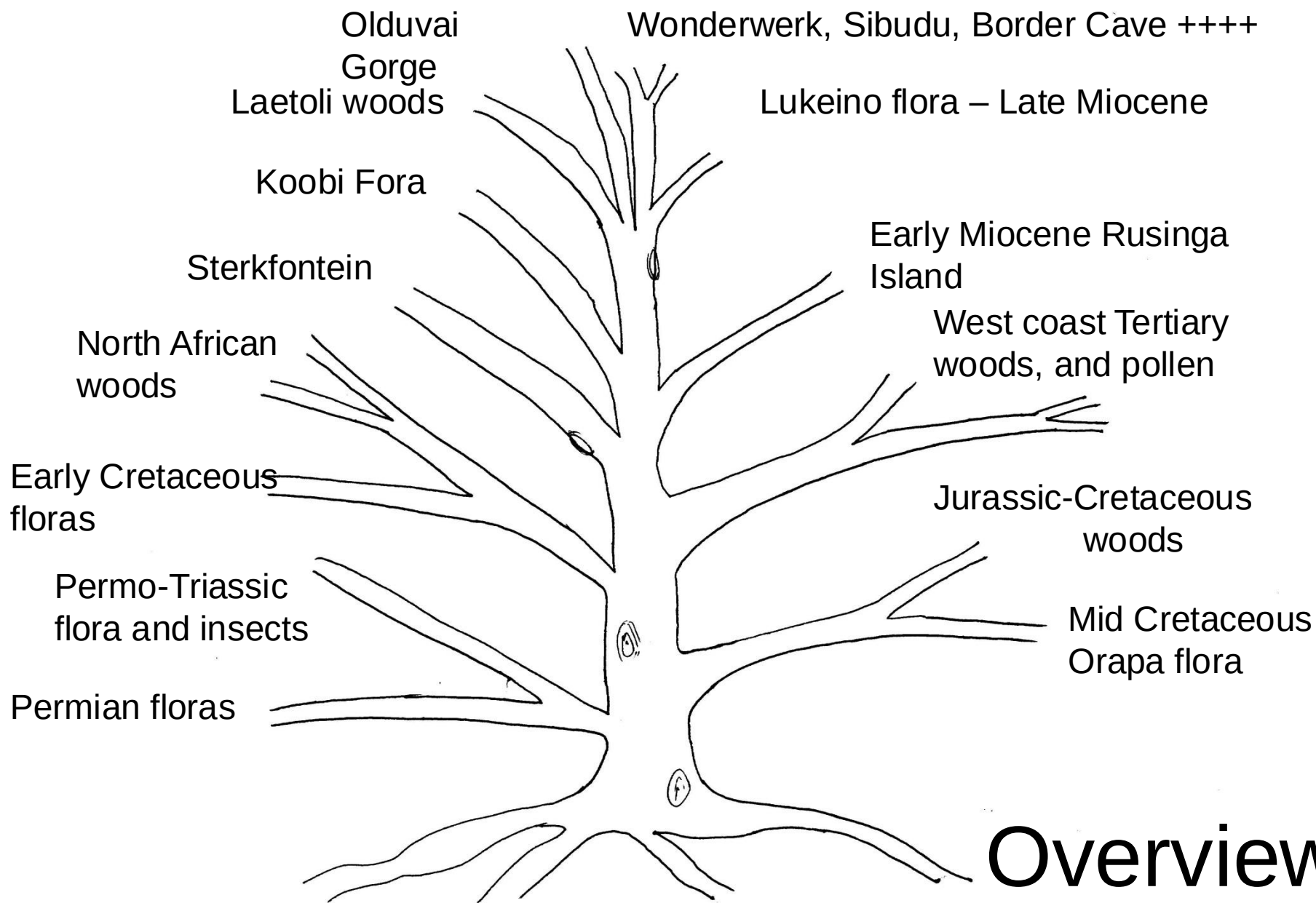
The many branches of the tree; a personal view of Palaeobotany in Africa

Marion Bamford

Inaugural lecture

University of the Witwatersrand

15 May 2014



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

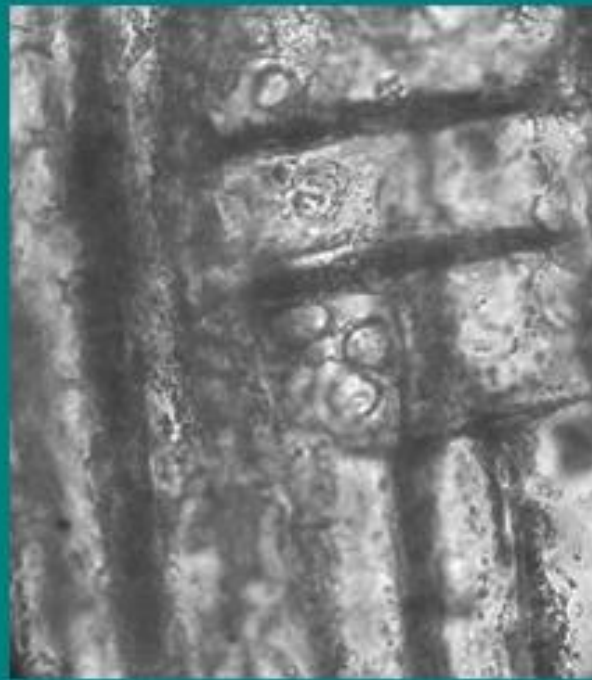
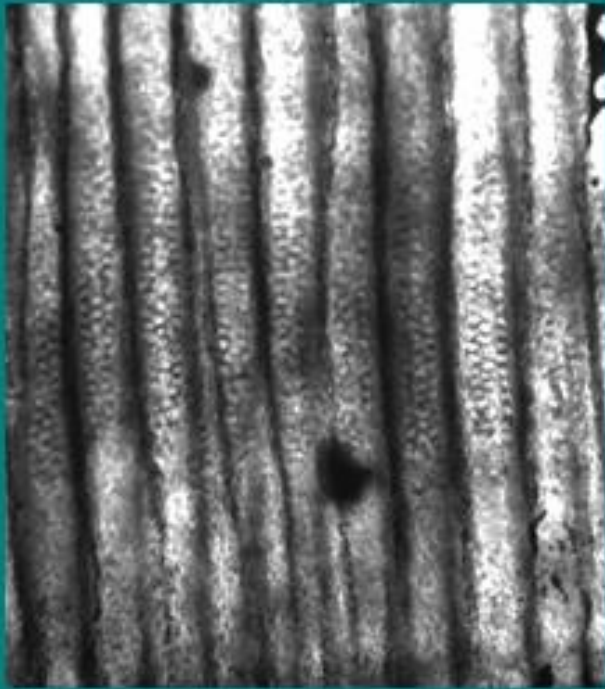
Silurian



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

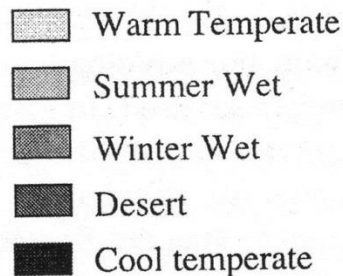
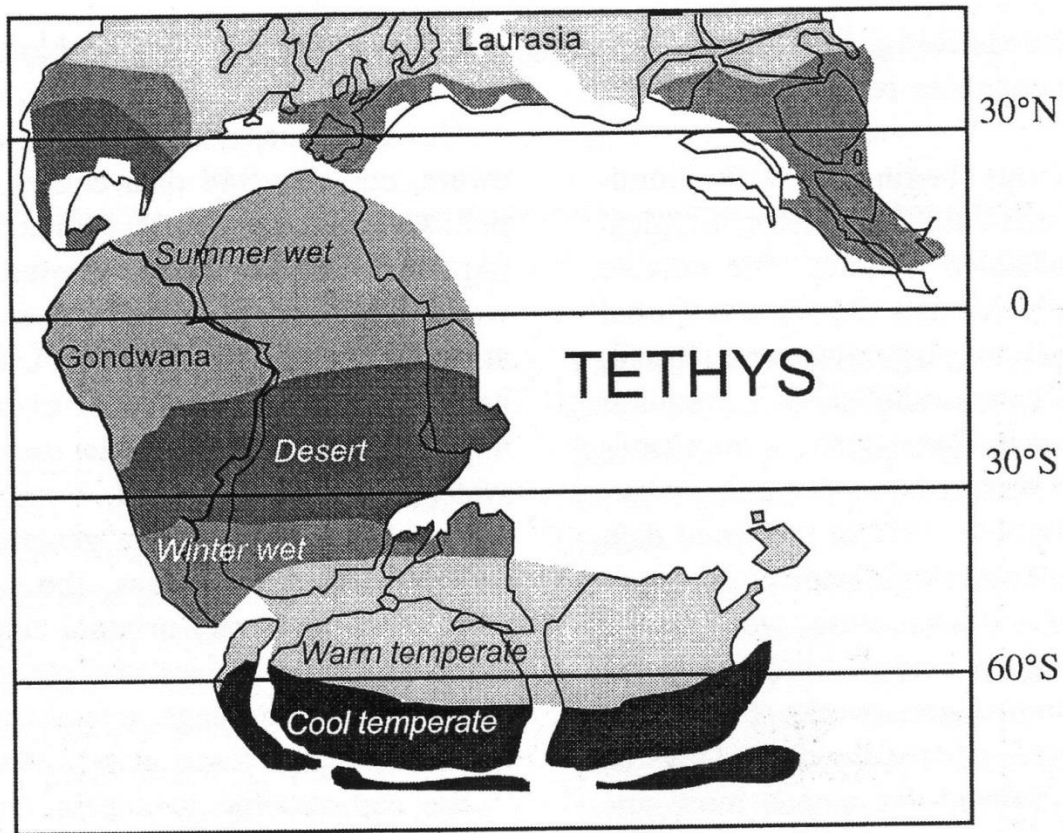
Devonian

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

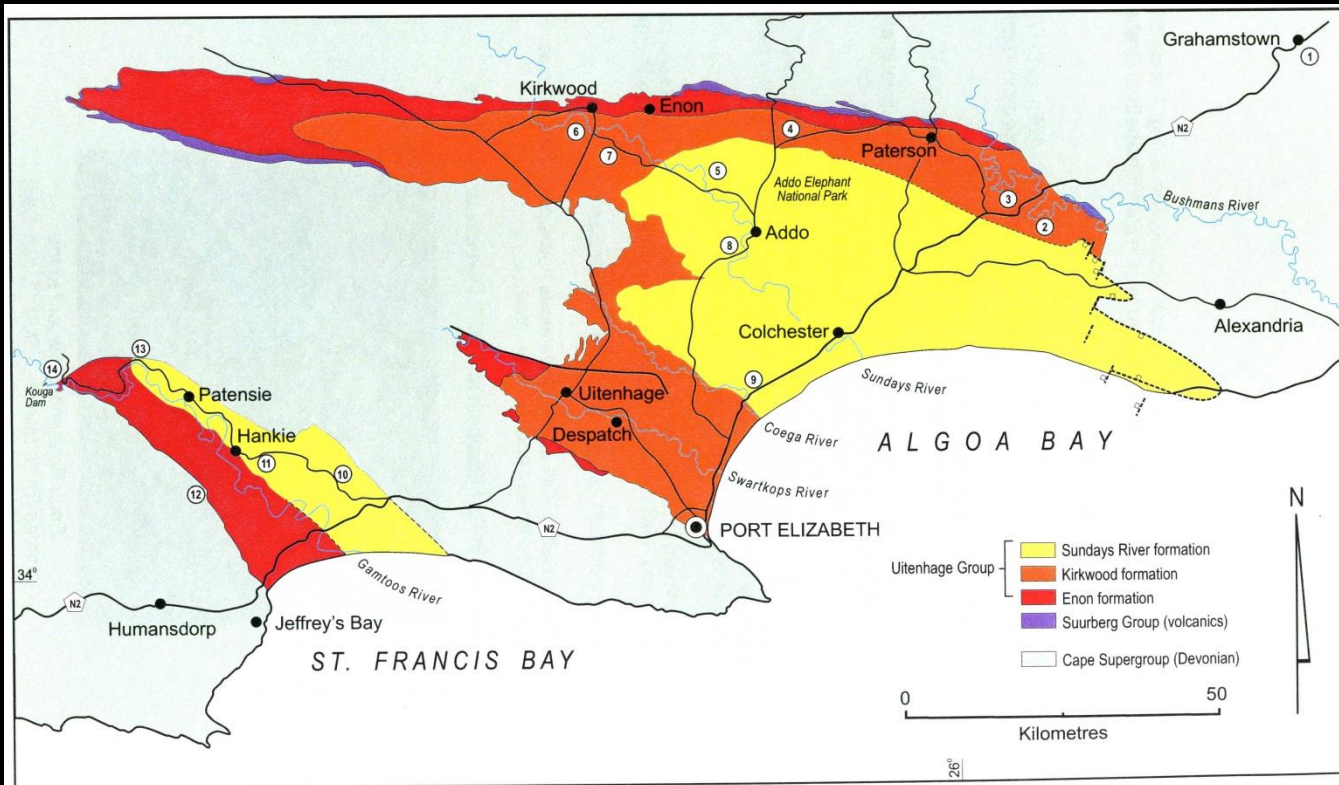
Carboniferous

Devonian

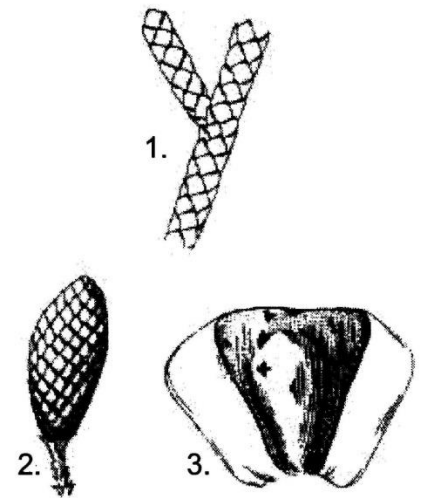
Silurian



Cycads



1. Branches of *Brachyphyllum* (common) - cuticle poorly preserved.
2. Reconstruction of araucarian cones
3. Scale leaf of *Araucarites rogersii* (common)



Conifers

Kirkwood Fm, Early Cretaceous;
cycads, conifers, ferns

Buizenhouts River

Charcoal – 5
conifer
species;

large-scale
fires



Kirkwood-
palaeofires
project

Tertiary

Cretaceous

Jurassic

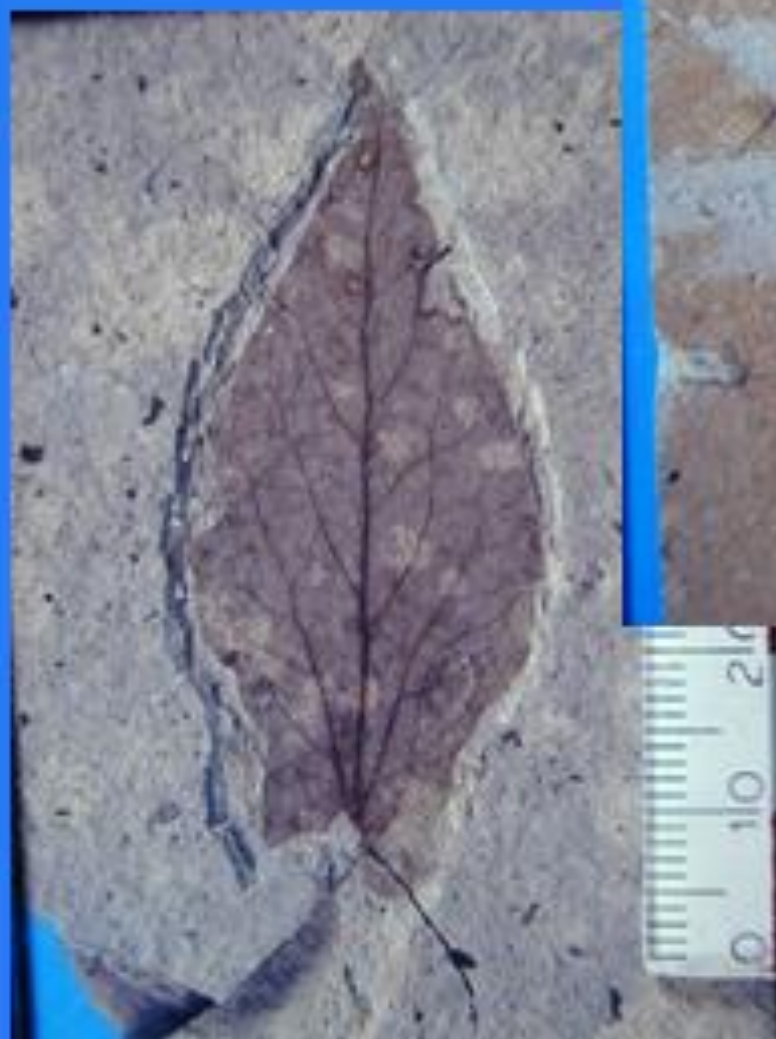
Triassic

Permian

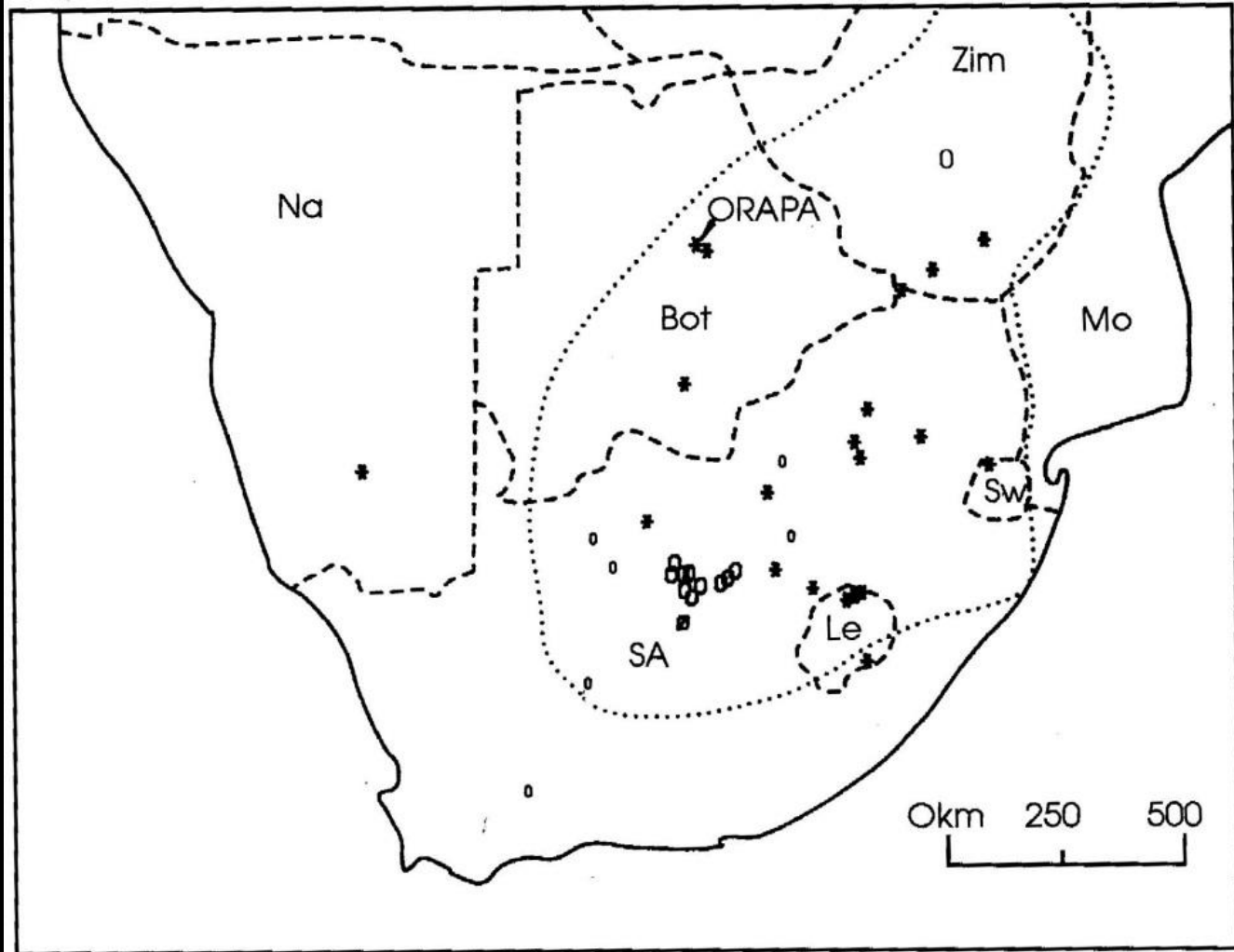
Carboniferous

Devonian

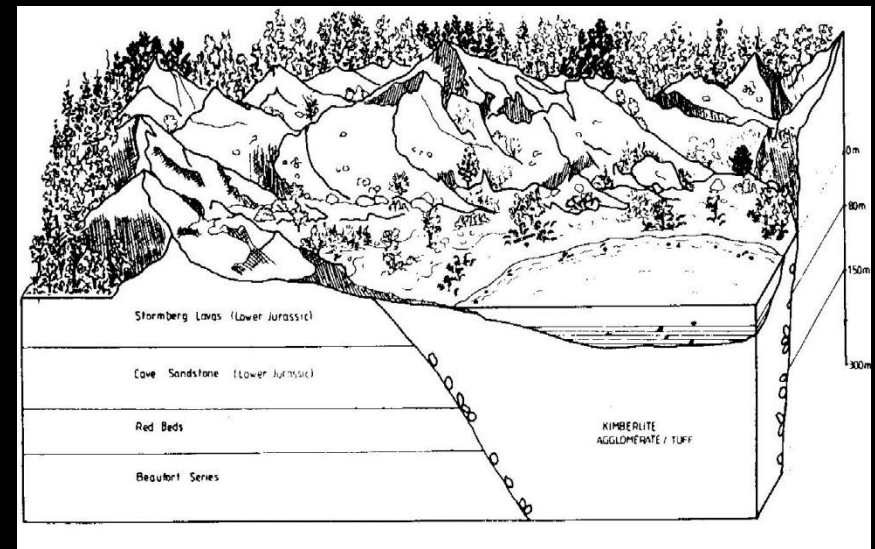
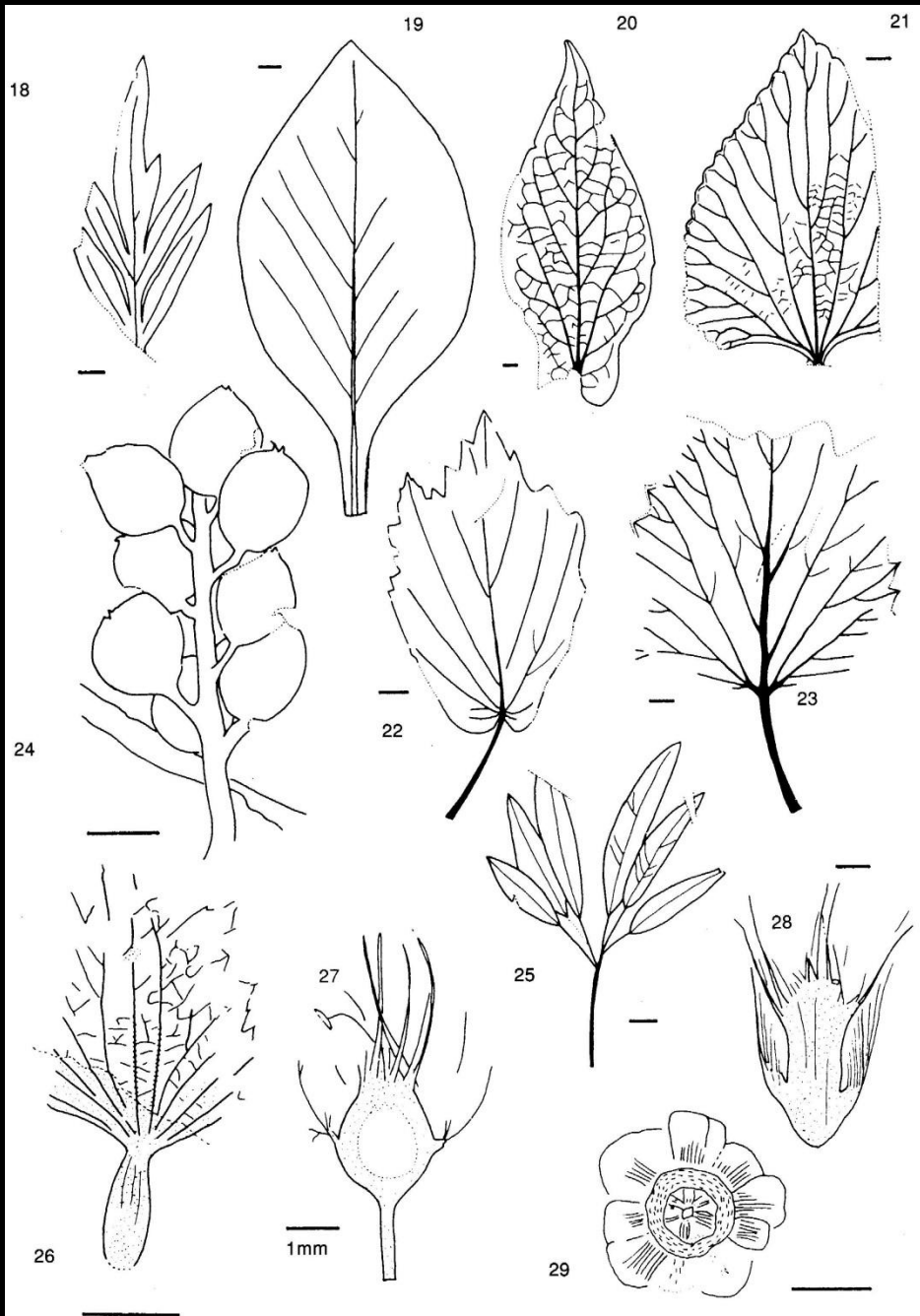
Silurian



Angiosperms



Orapa kimberlite pipe



Numerous insects
Angiosperm leaves
Ferns
NEW: climate from leaves

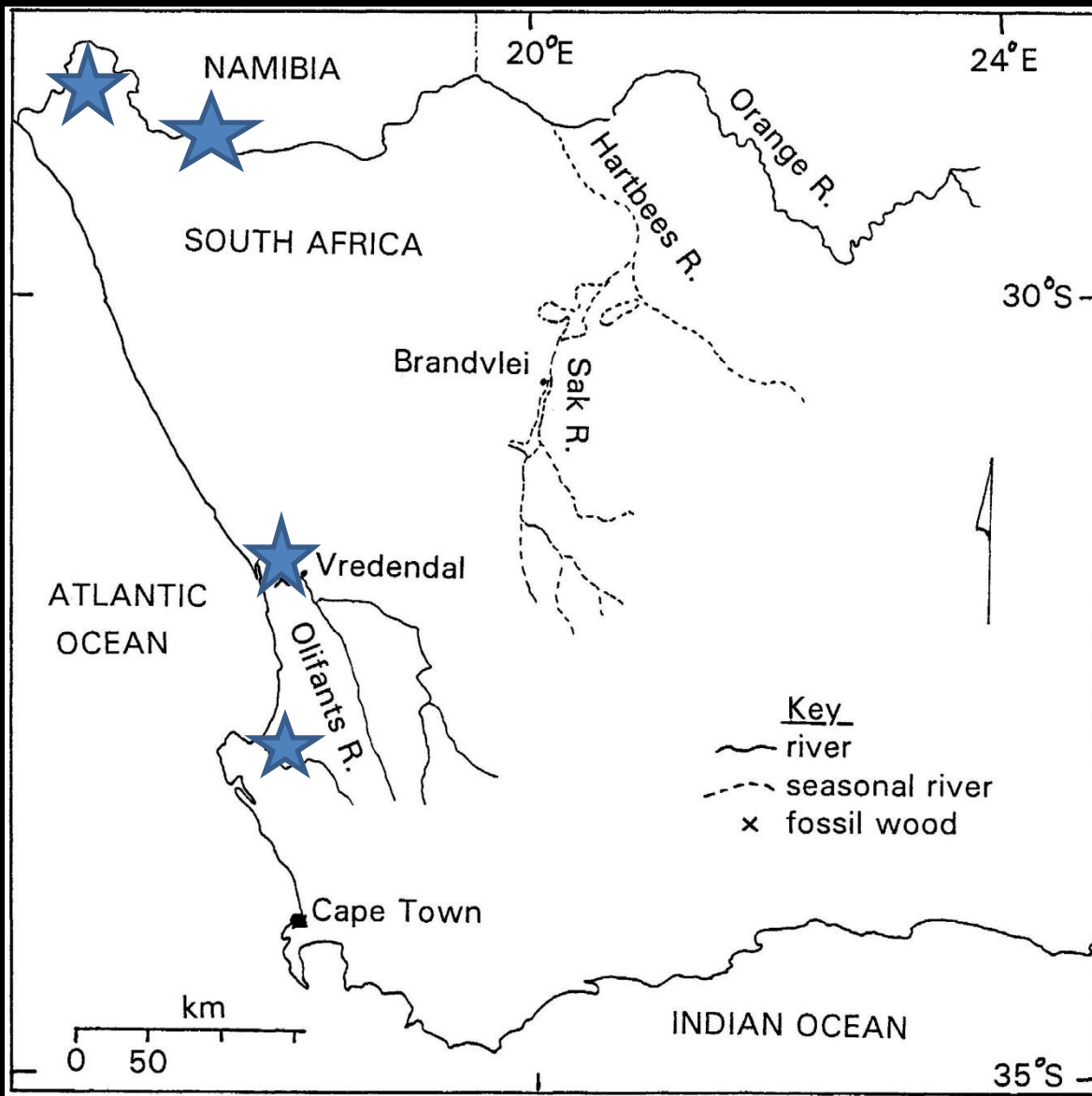
Late middle
Cretaceous
Orapa flora

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

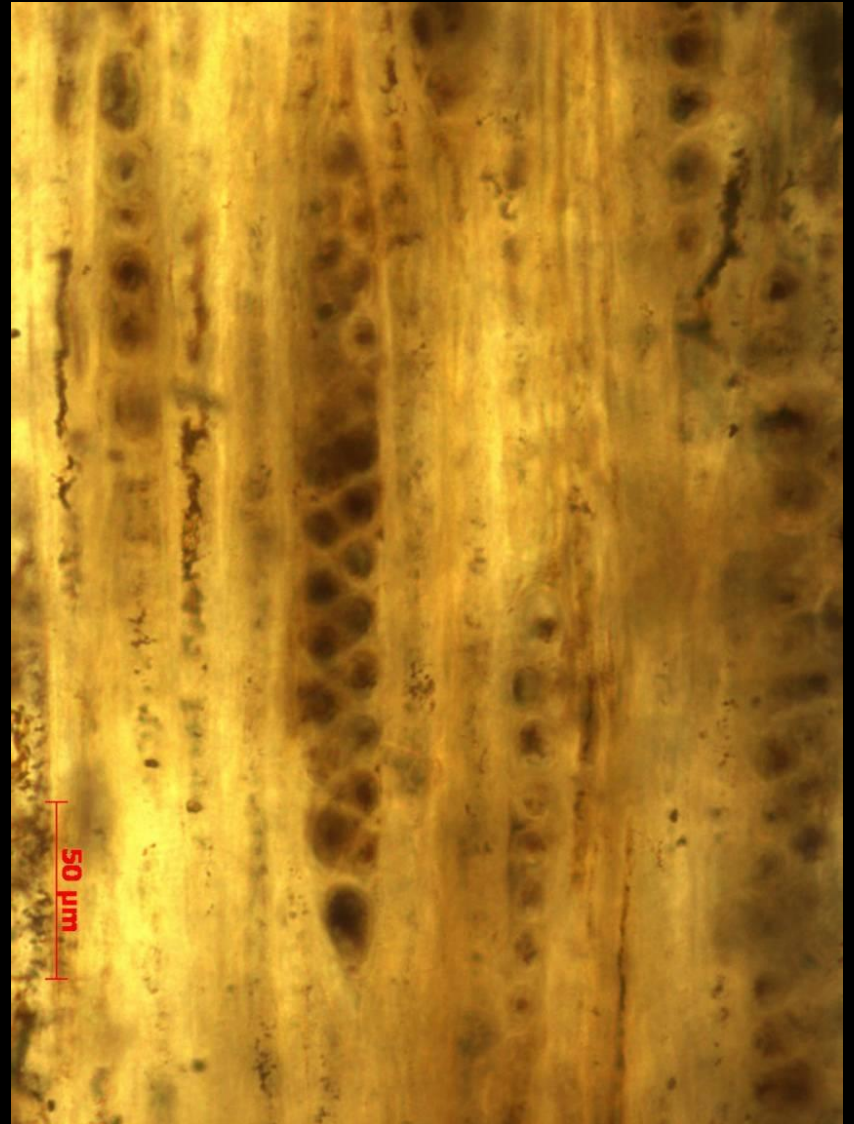
Miocene West coast woods

Vredendal Miocene

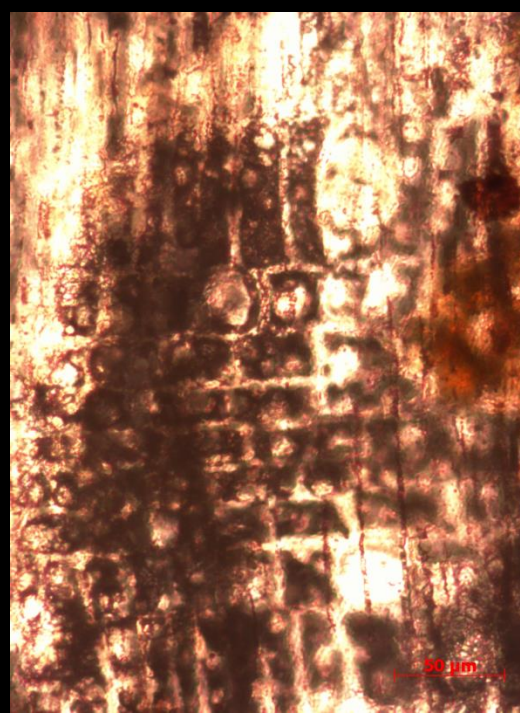
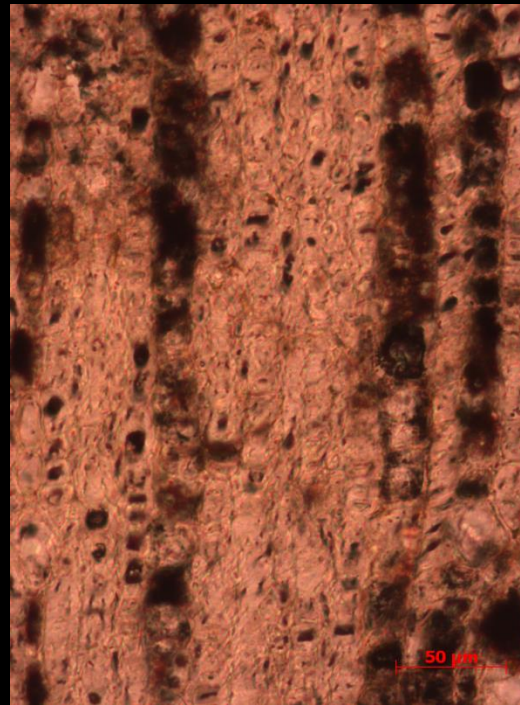
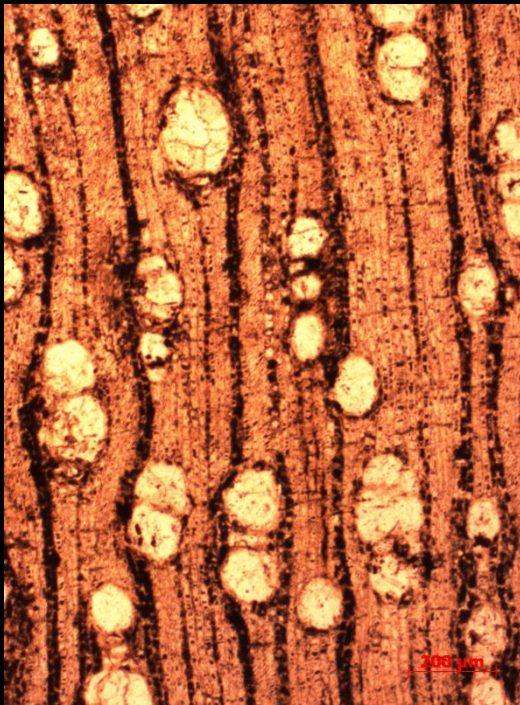


Meliaceae
Combretaceae

Bamford 1999



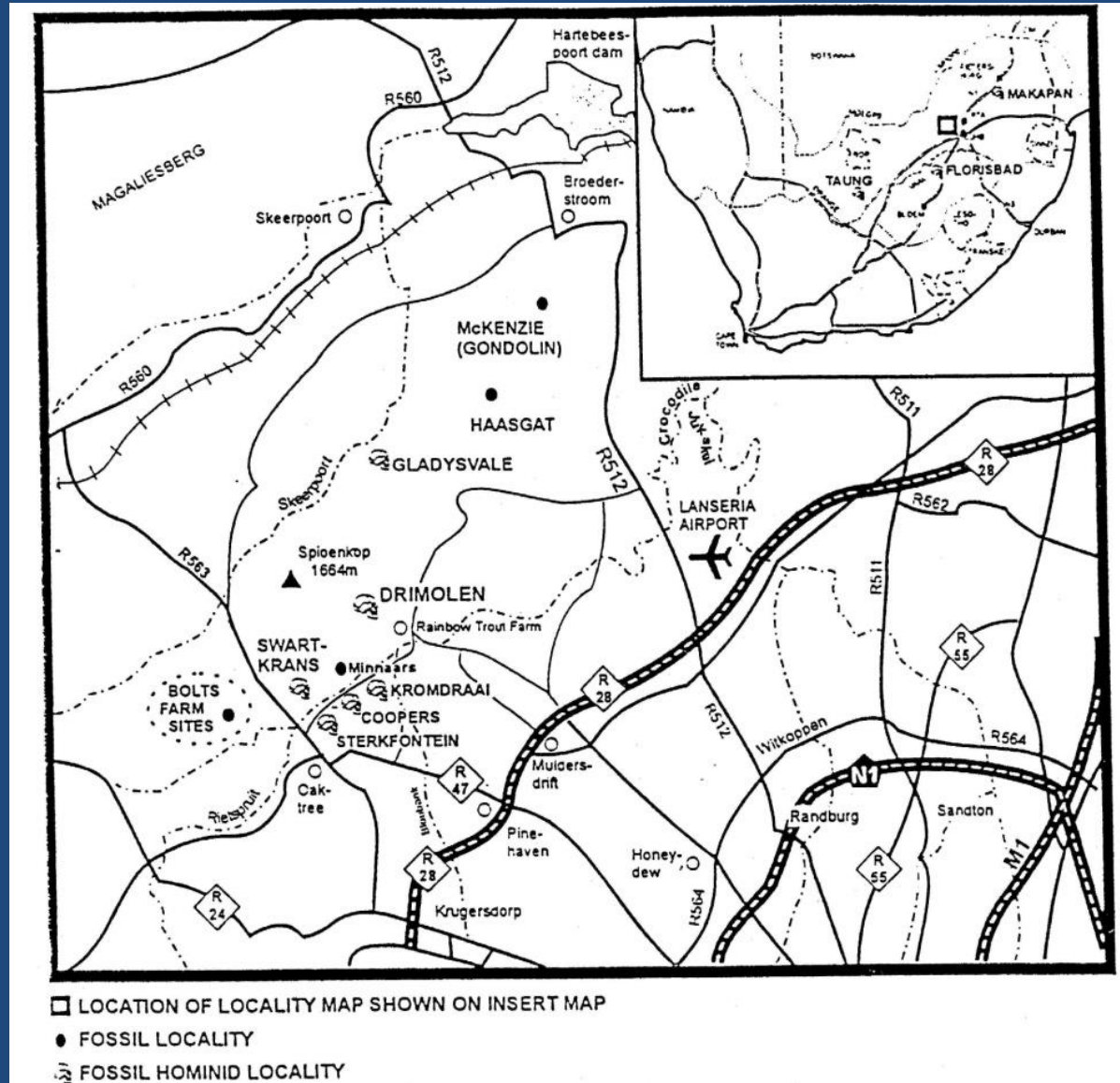
Arrisdrift Miocene



Burseraceae
Combretaceae
Fabaceae

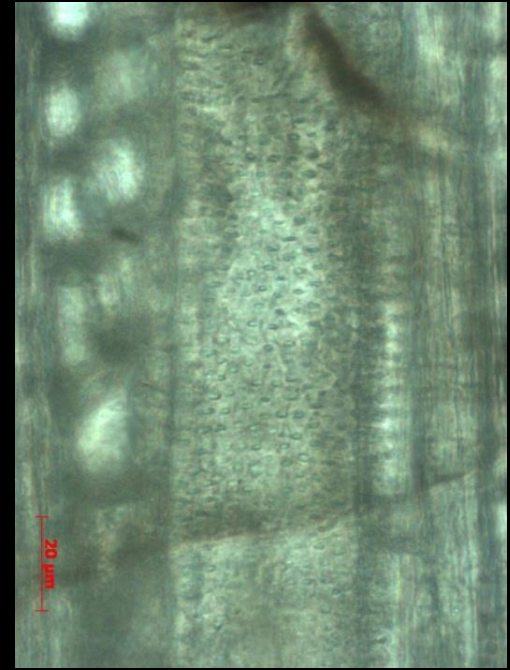
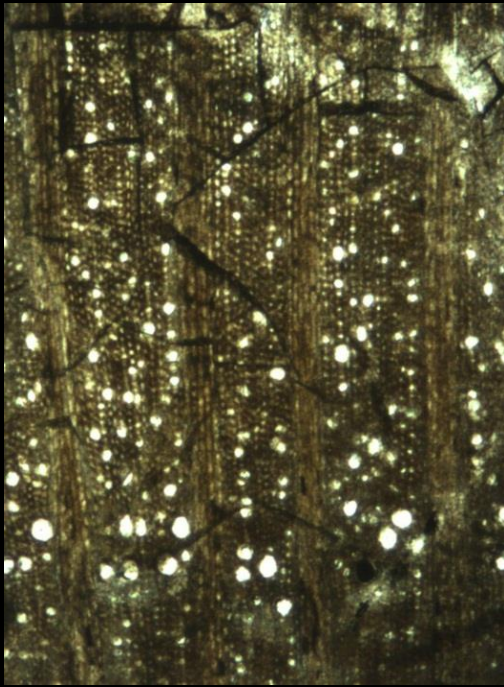
Cradle of humankind sites /Sterkfontein valley

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



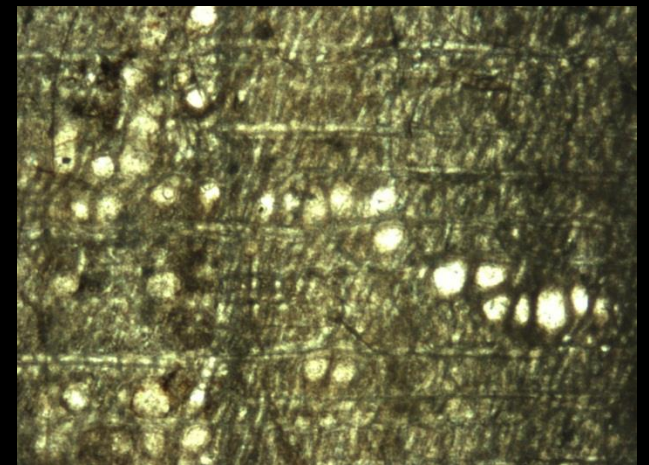


Sterkfontein fossil woods

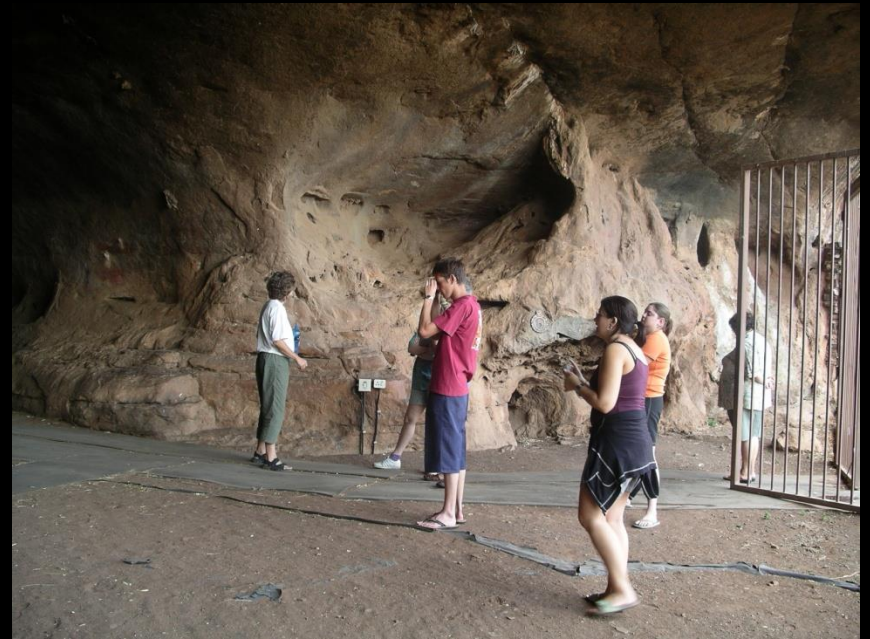
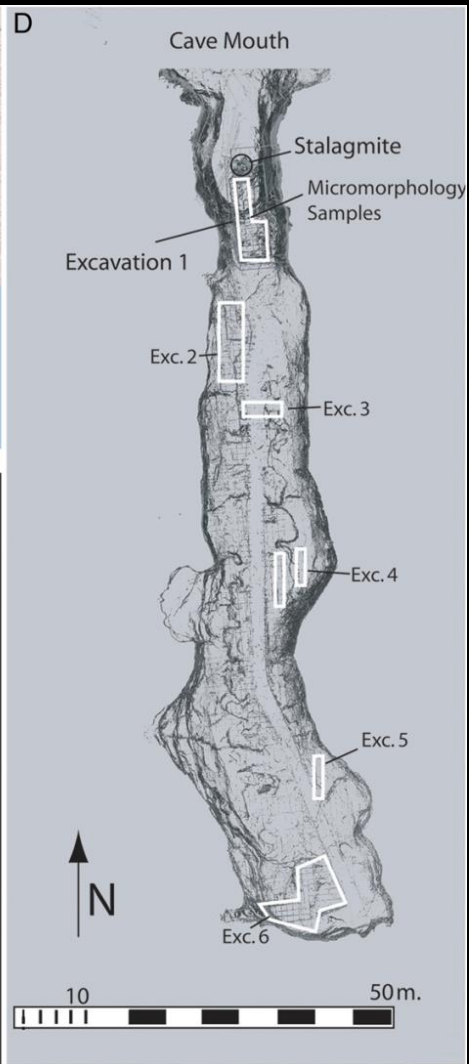
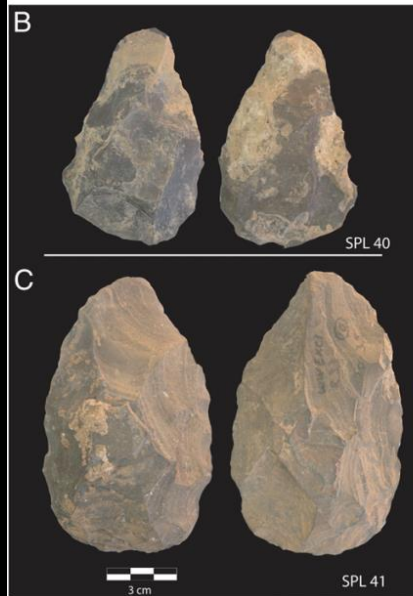


Dichapetalum mombuttense; *Anastrabe intergerrima*

Sterkfontein Mbr 4



Wonderwerk Cave (2Ma – 0Ma)



Excavation 1 (near entrance)

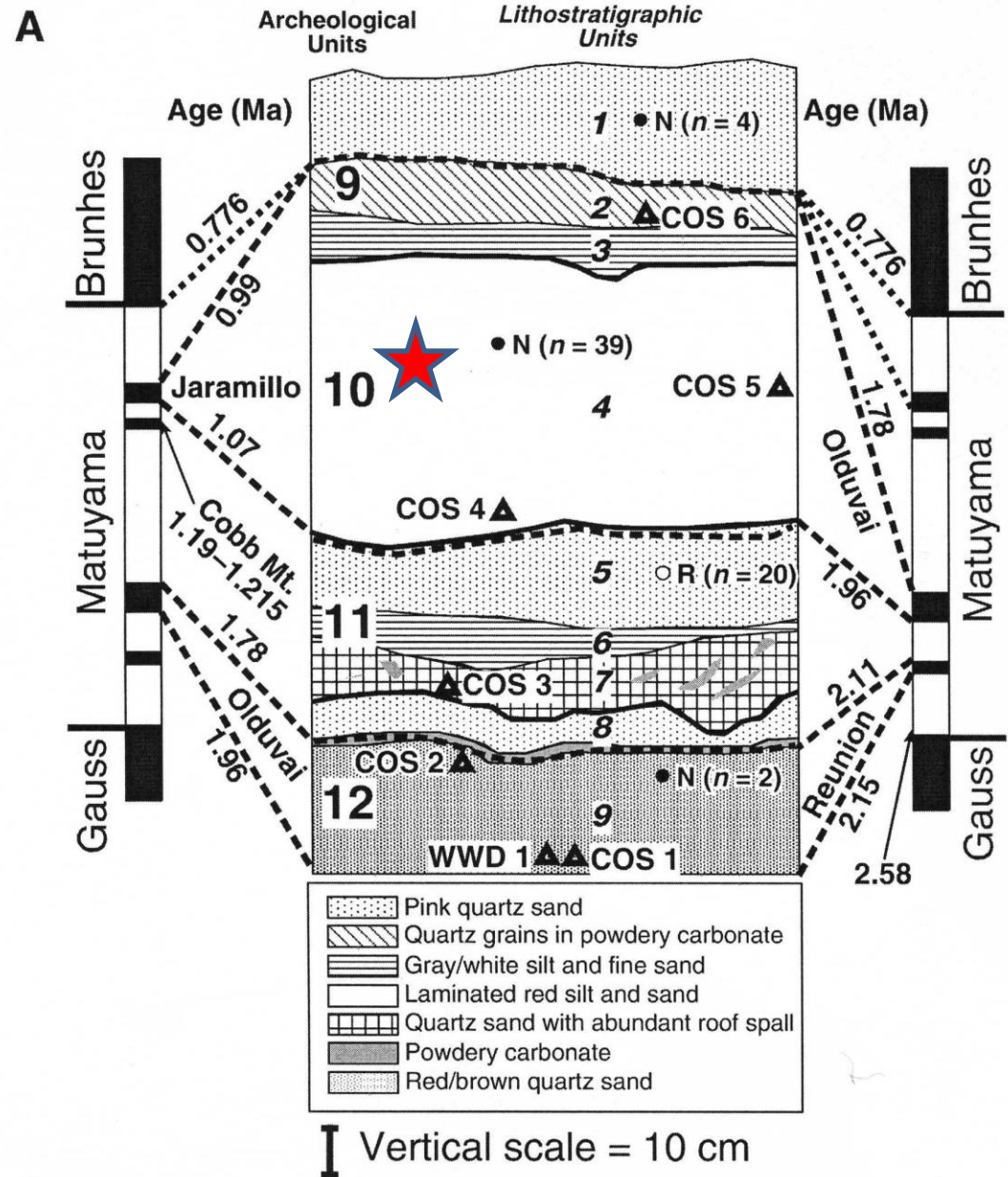


Peter Beaumont ca 1970-1990

Michael Chazan, Liora Horwitz

Wonderwerk Cave, Northern Cape Excavation 1.

1. Good dating
2. Microstratigraphy

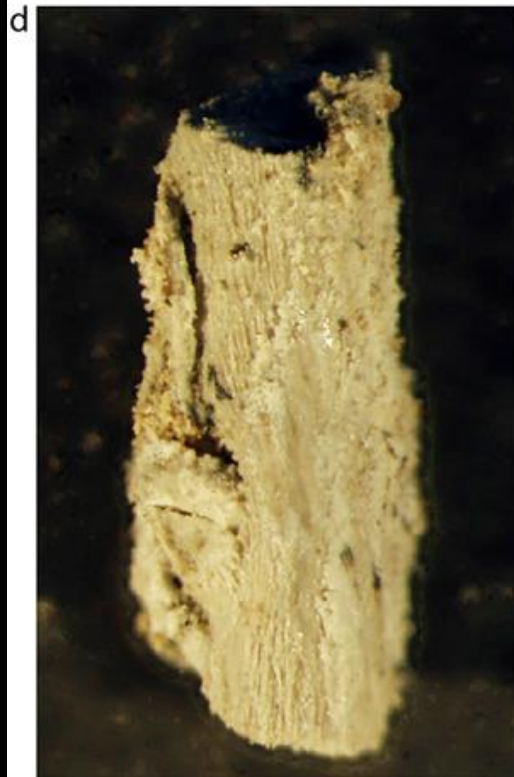


5. Burned plant fragments - fuel

Sedge



Dicot wood



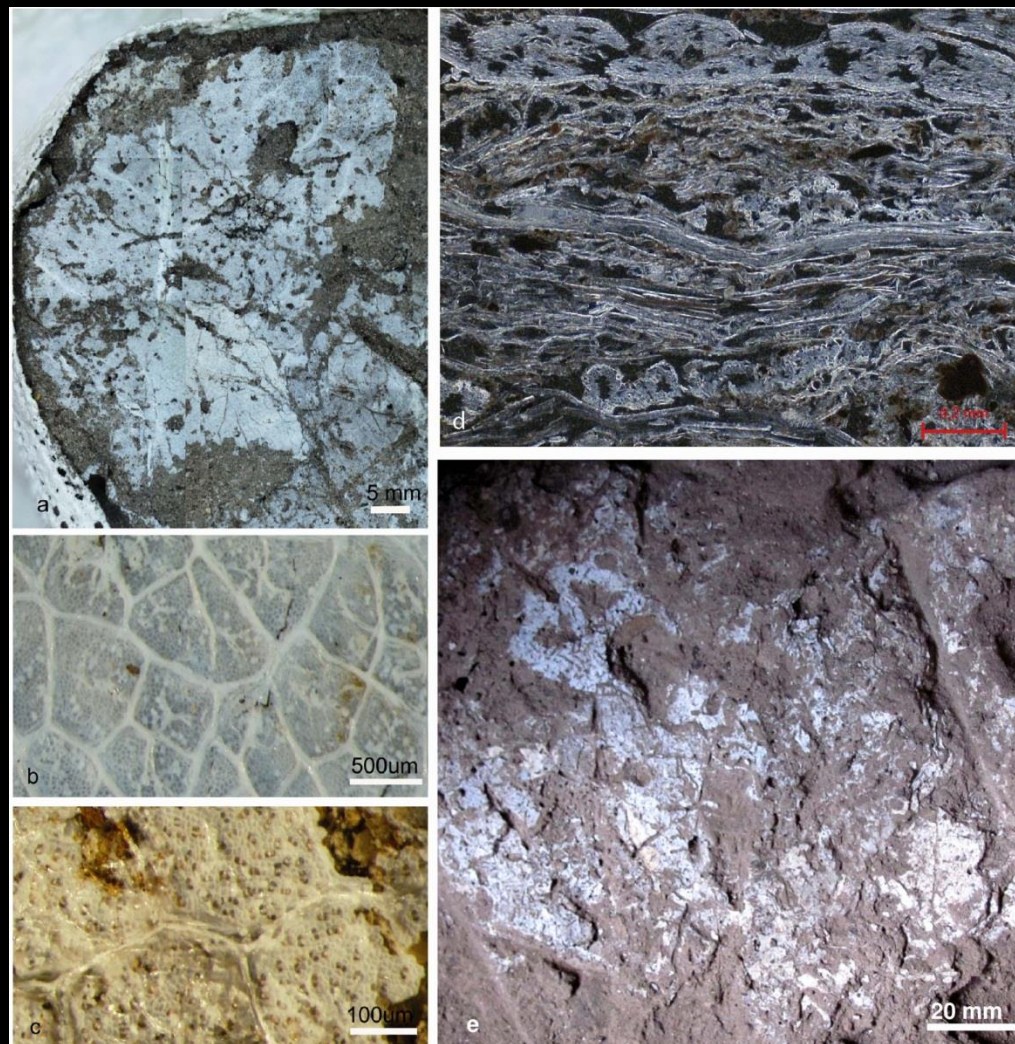
Oldest evidence of the controlled use of fire at Wonderwerk:

- 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**



Sibudu rockshelter and medicinal plants

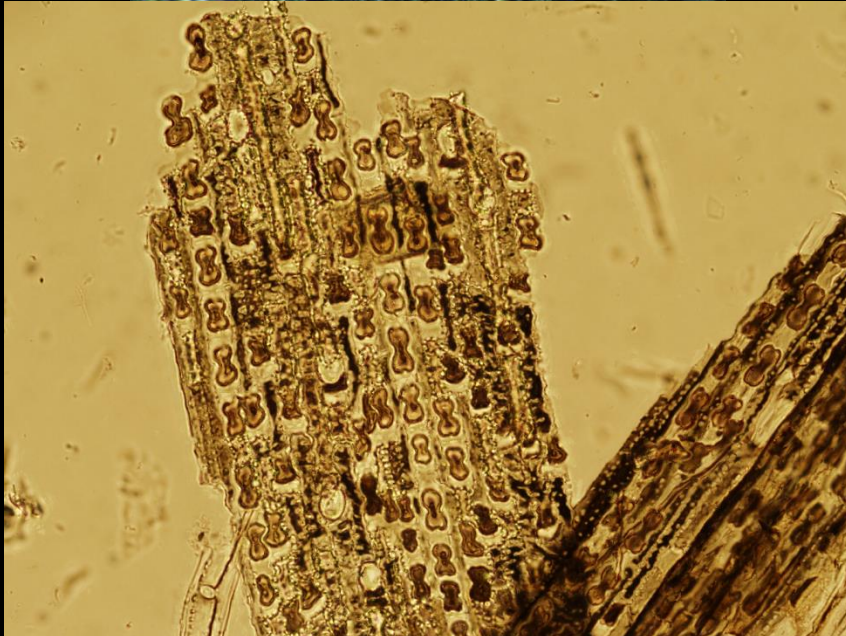
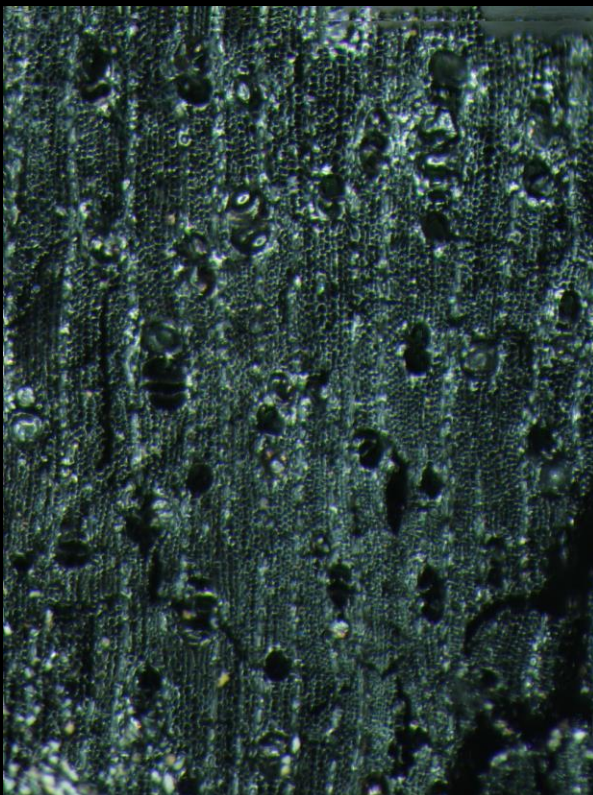
Wadley et al., 2011, Science,
77 000 years ago



Cryptocarya woodii (Lauraceae)

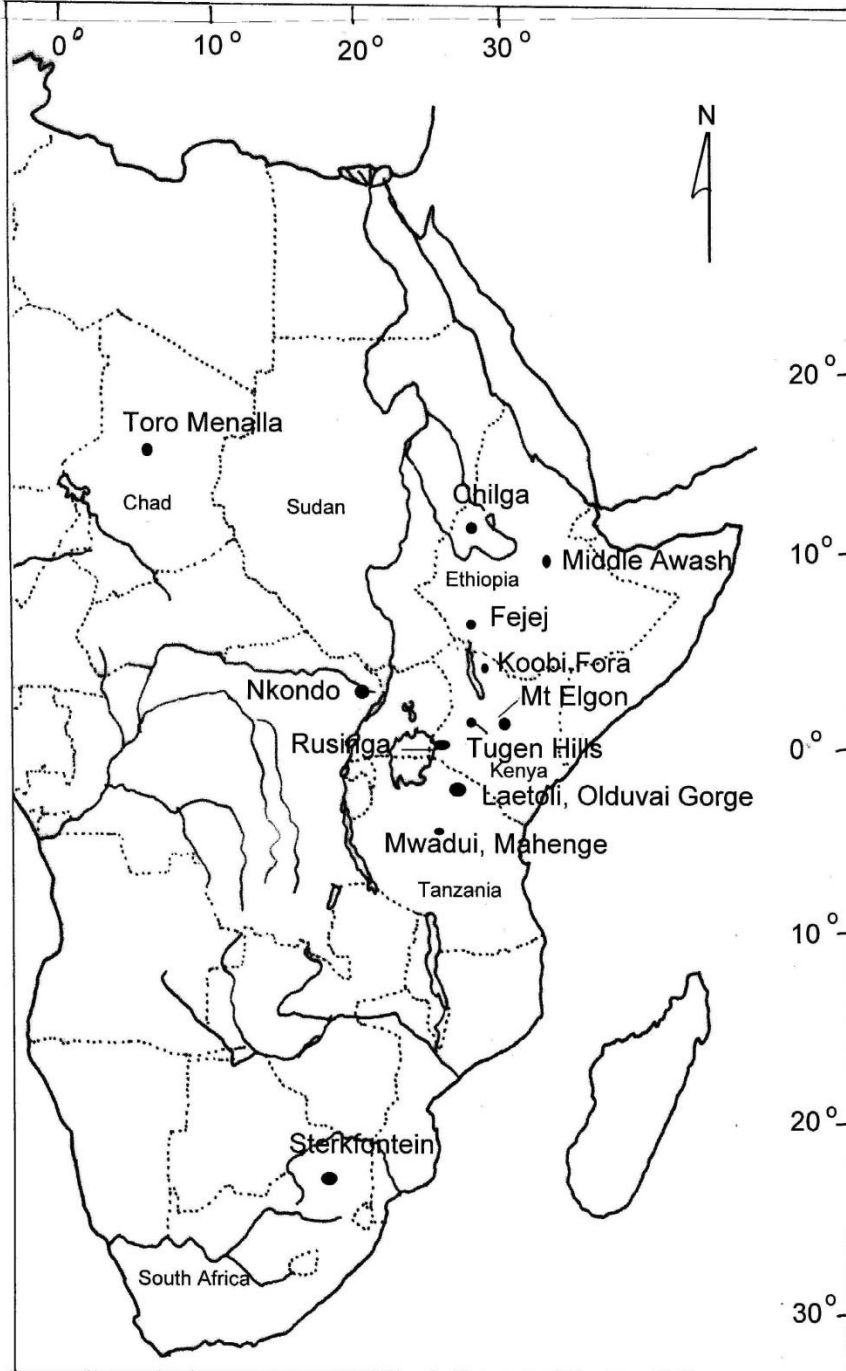
Research at Sibudu Rock Shelter KZN

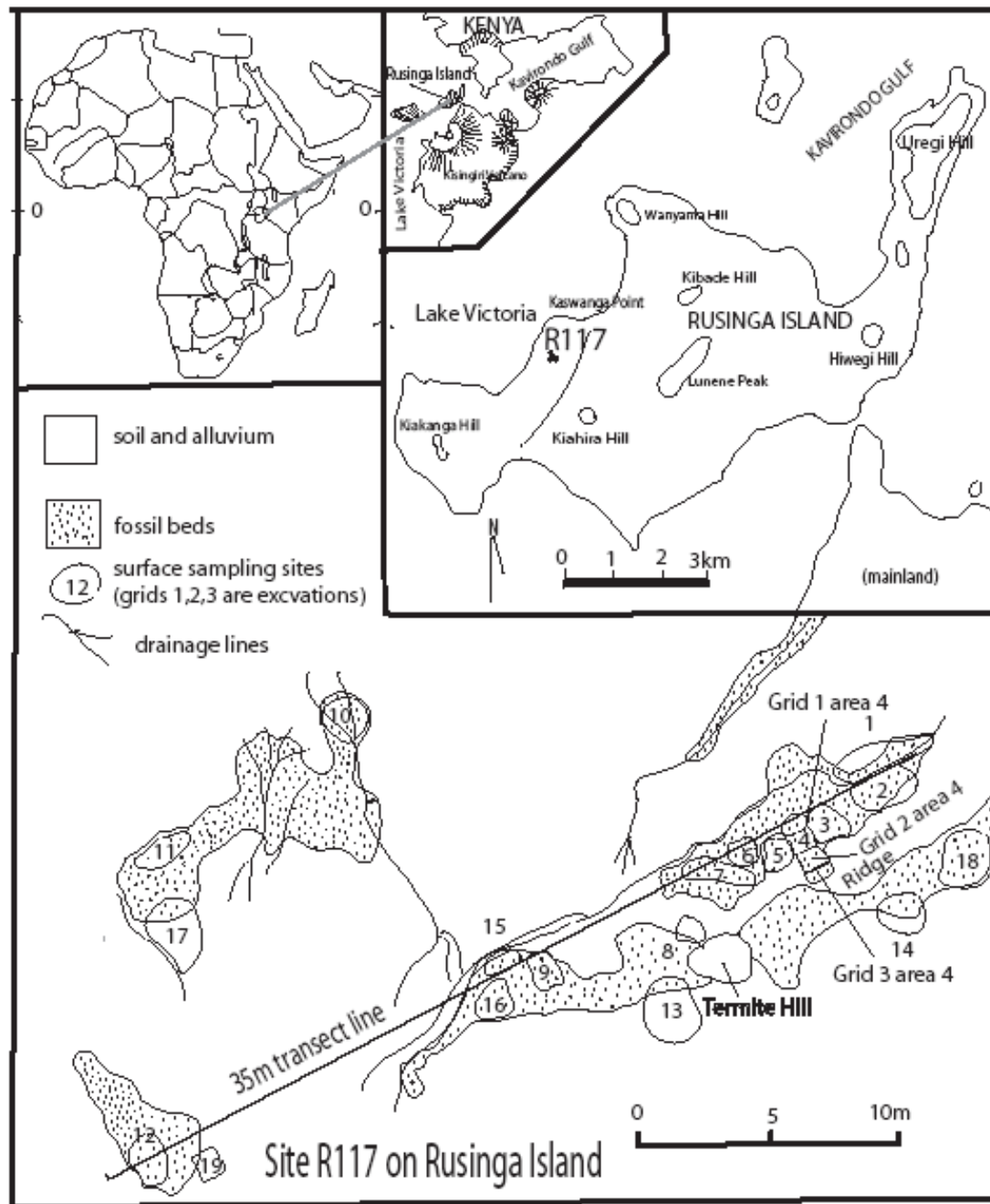
- MSA artefacts; fauna
- Charcoal
- Medicinal plants
- PhD student: Sandy Lennox
- *Spirostachys africana*,
Tarchonanthus camphoratus
- Phytoliths
- Modern reference material
- PhD student: May Murungi



EAST AFRICA

Miocene - Pleistocene





Early Miocene (18Ma) Rusinga Island, Kenya

Fauna, hominoids
Seed endocasts
Leaf impressions

Collinson, Andrews,
Bamford, 2009. JHE



Kaswanga Point

Rusinga Island – Early Miocene



Rusinga Island: Kaswanga Point – Hiwegi Formation



Climate from leaf
physiognomy

Rusinga Island leaves



Maxbauer et al. 2013. Pal. elect



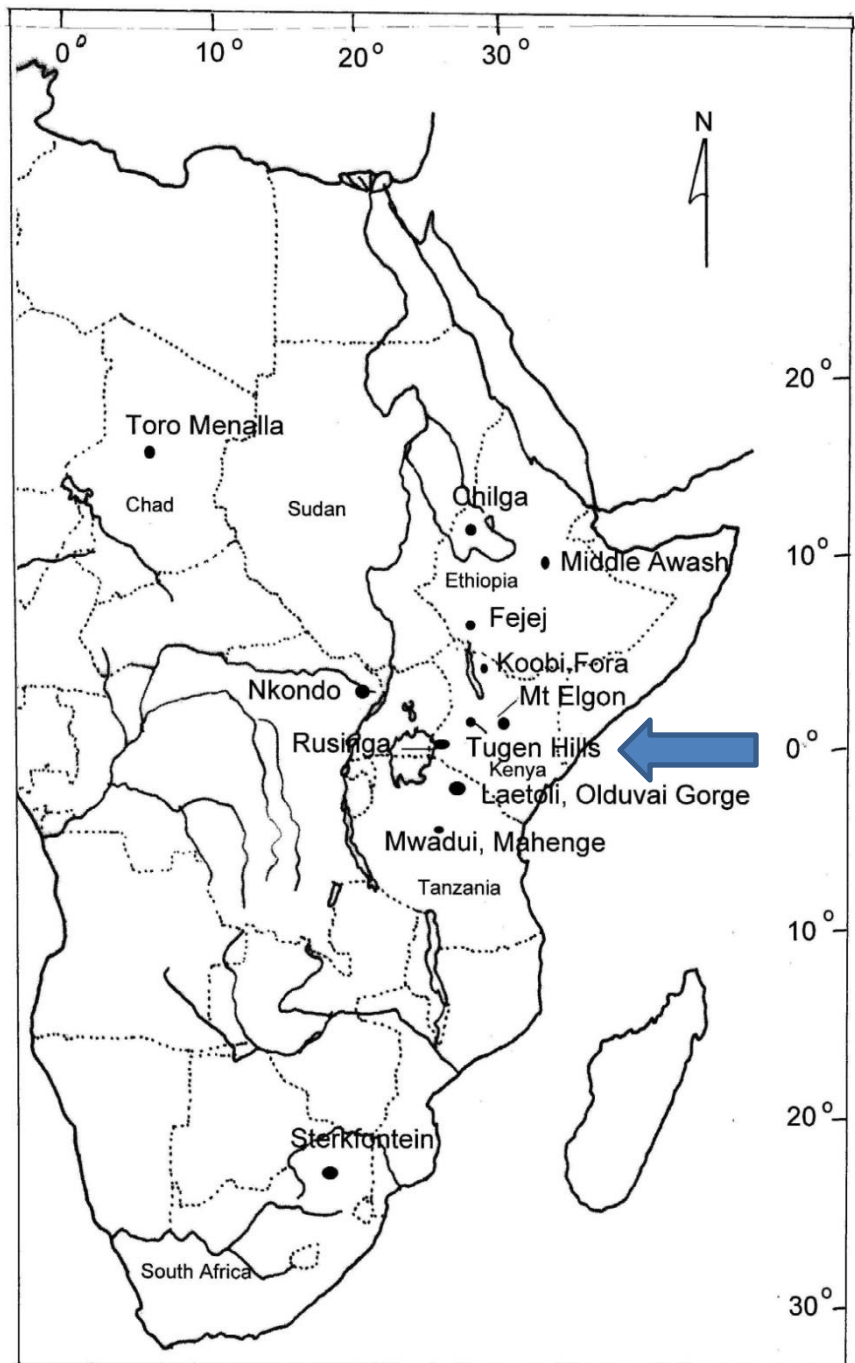
	RUSINGA / MFANGANO PALEOANTHROPOLOGY	
Field #: <u>RV-2010-573</u>		Date: <u>30-06-10</u>
Locality: <u>RUSINGA</u>	Site: <u>R3</u>	
Area: <u>Woregi</u>	GPS: _____	
Horizon: <u>Fossil bed 11b</u>	Collector: _____	
Taxon: <u>Plantae</u>	_____	

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

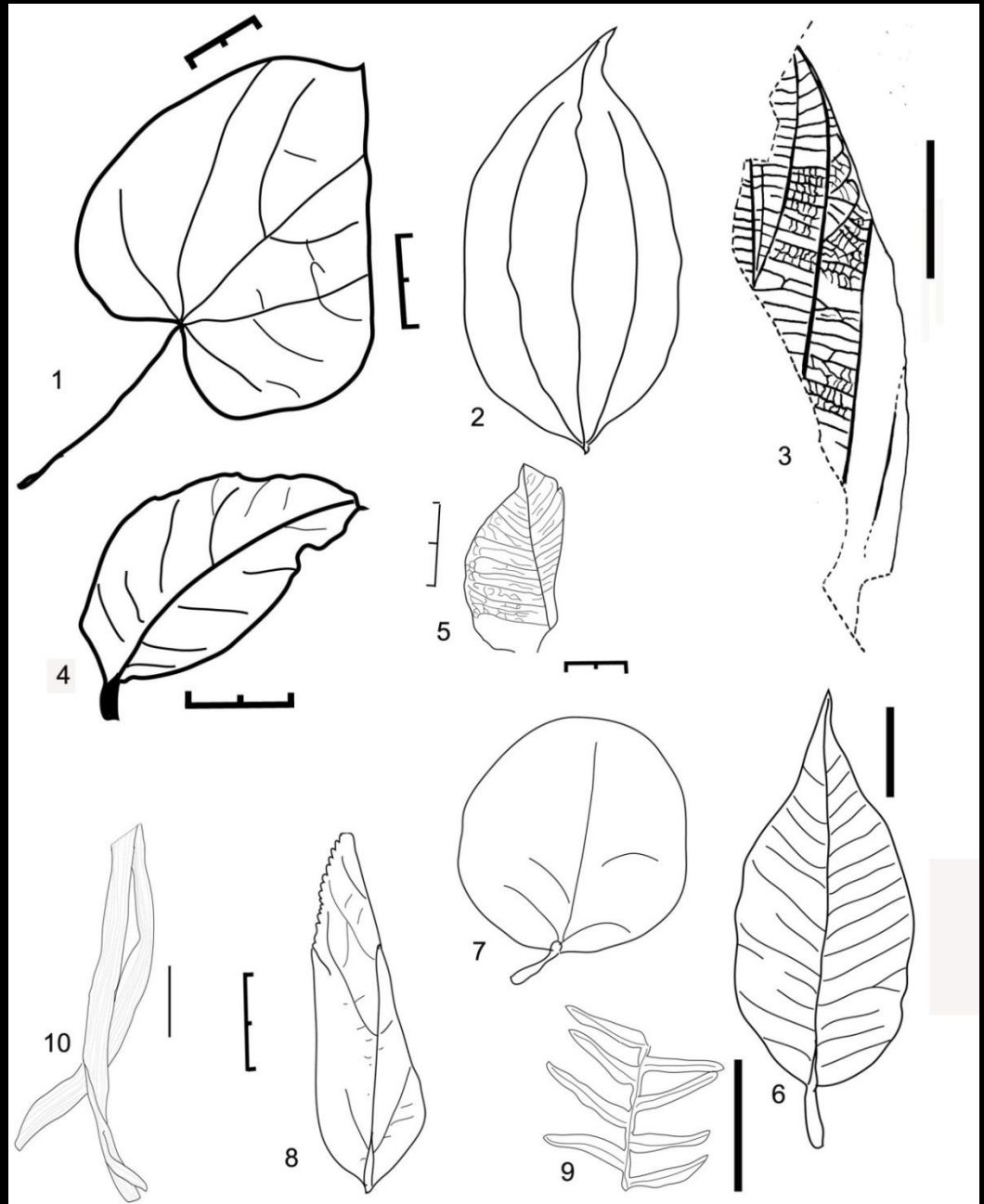
Apex shape

Base shape

Margin – teeth &
type

Margin – entire

etc

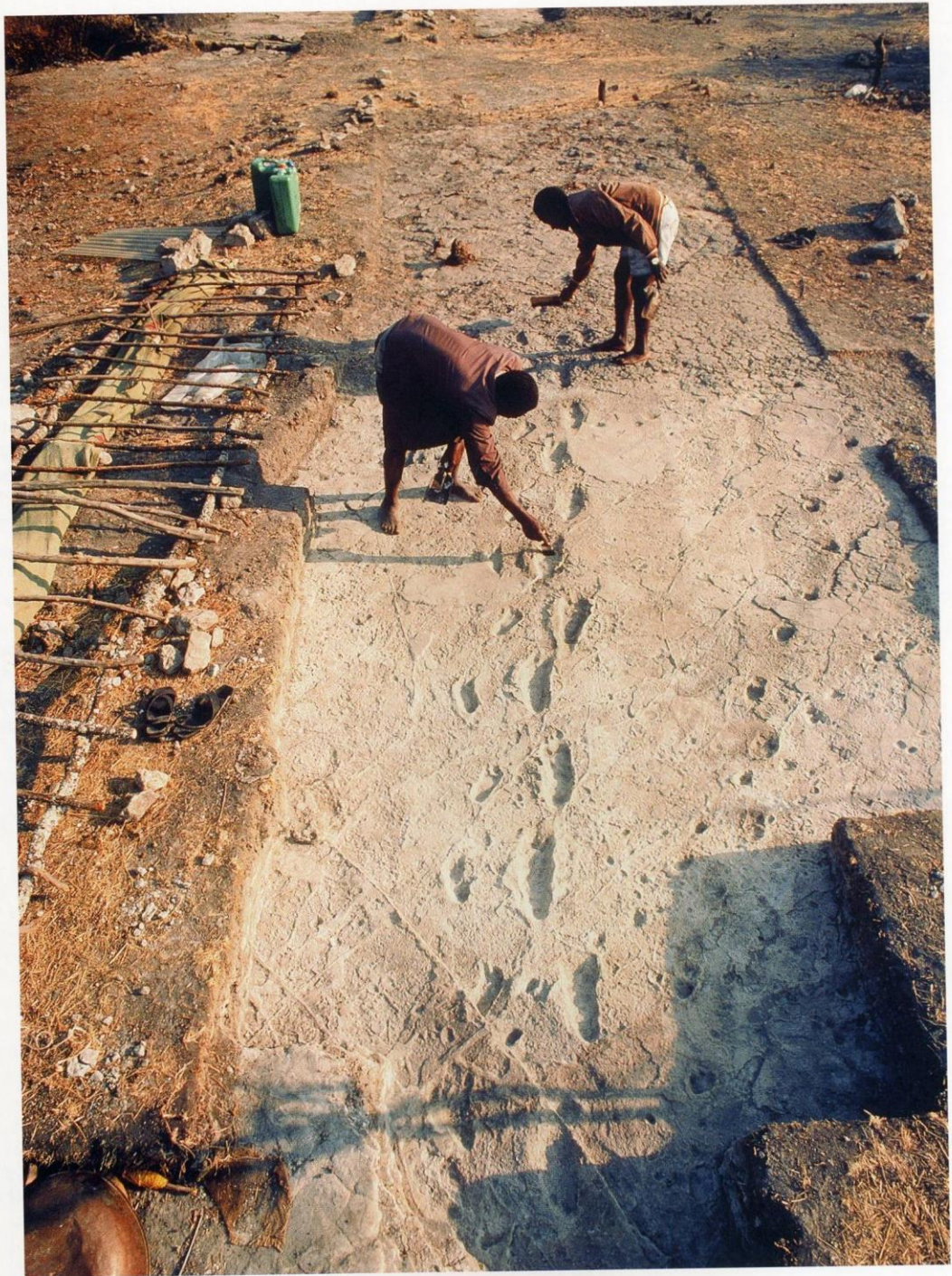


CLAMP results from Kapcharar

- 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 woodland
 - with open areas nearby



Footprints at Laetoli



Summary of projects:

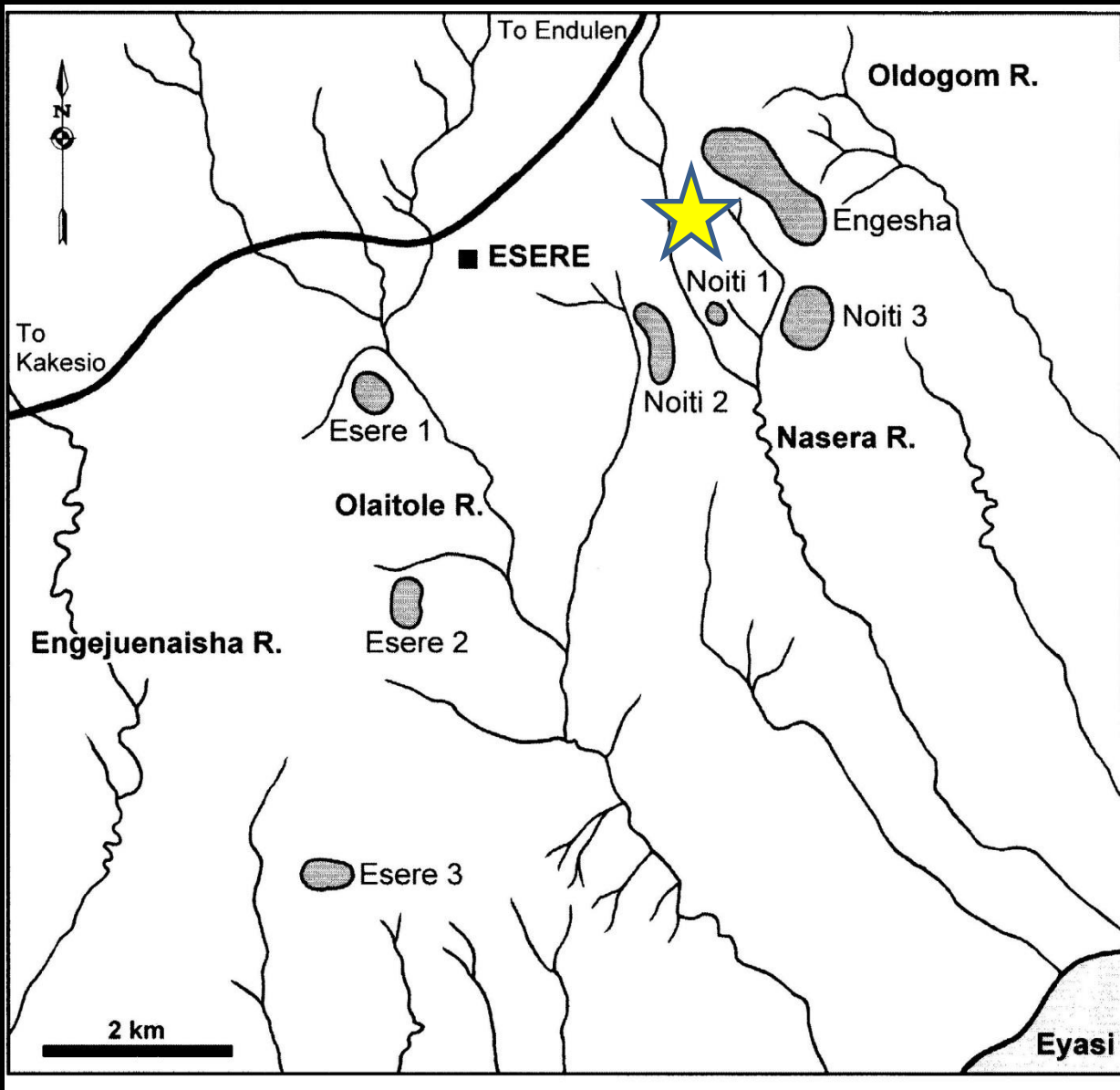
Upper Laetolil Beds, Laetoli, Tanzania

Features

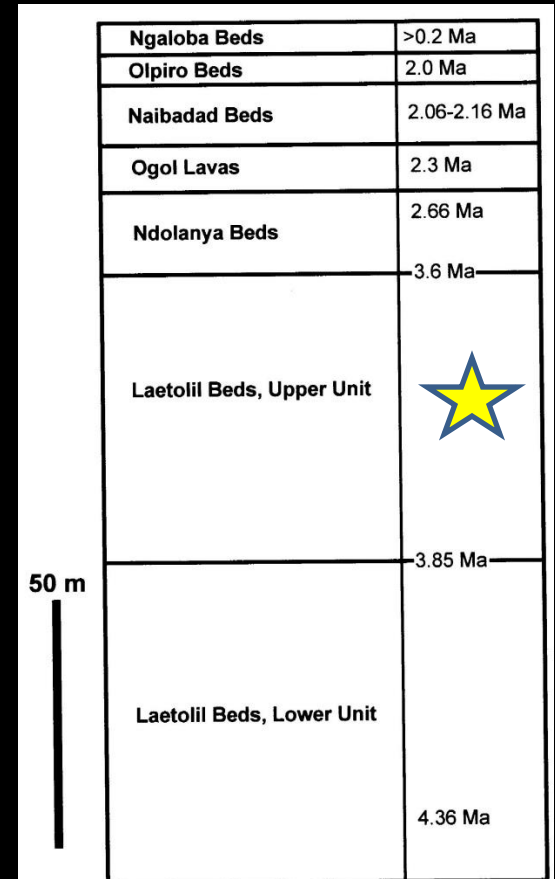
- Hominin footprints
- *Australopithecus afarensis*
- Diverse fauna
- Palaeoenvironment
 - Riverine setting, no lake
 - Mosaic woodland

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 Laetoli 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

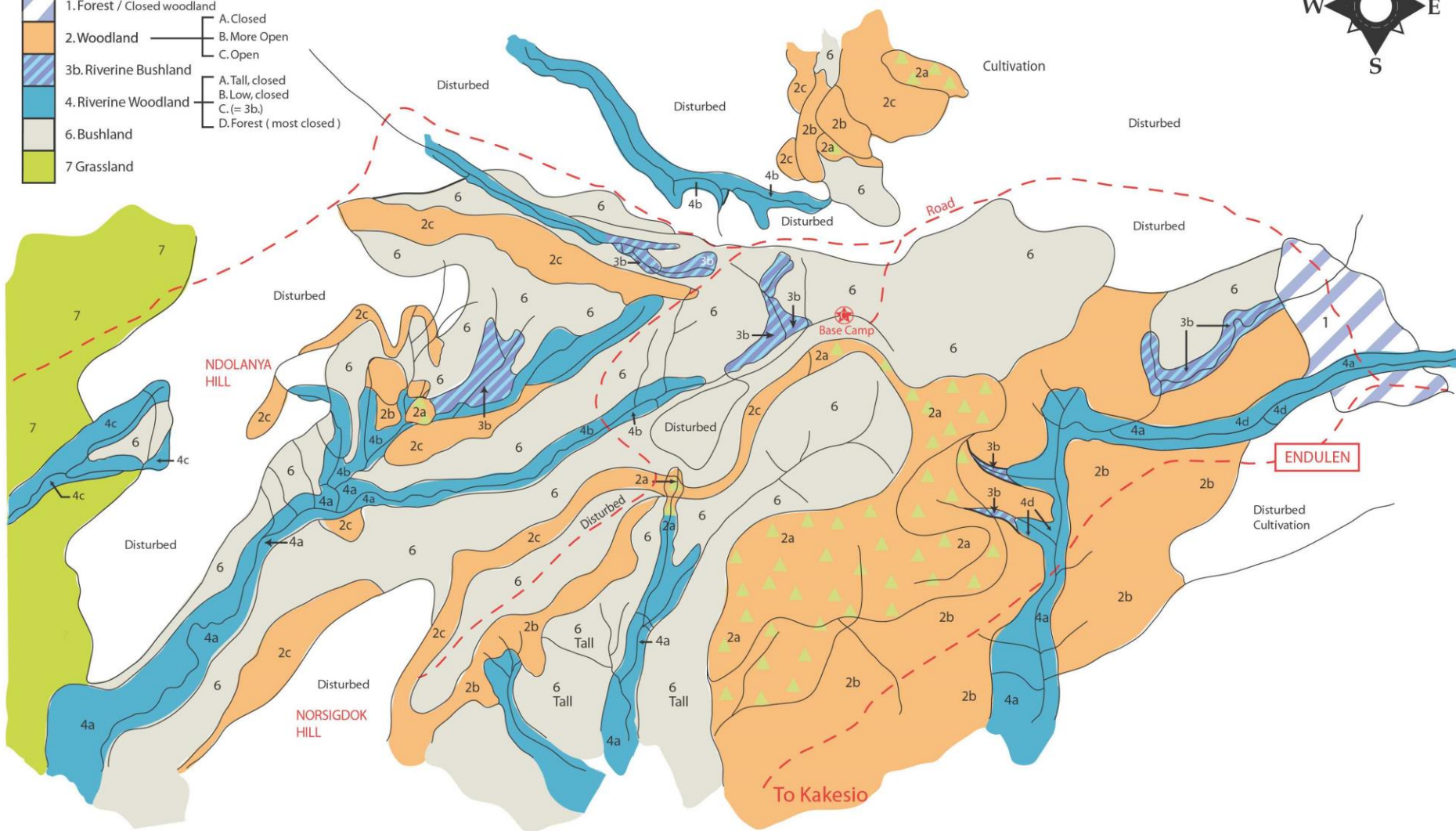
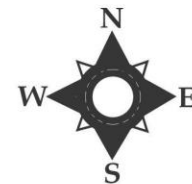
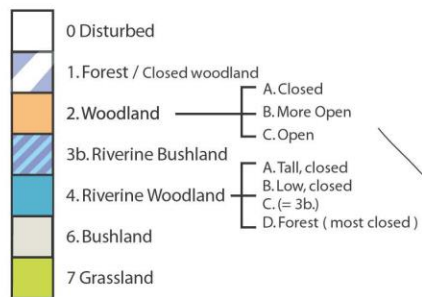


Laetoli, grass on mbuga

7 Vegetation types recognised: eg

Vegetation unit 2: Deciduous woodland (4 subunits)

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



Laetoli Site, Tanzania

Vegetation Map

Predictions for changing climate:

Increased rainfall

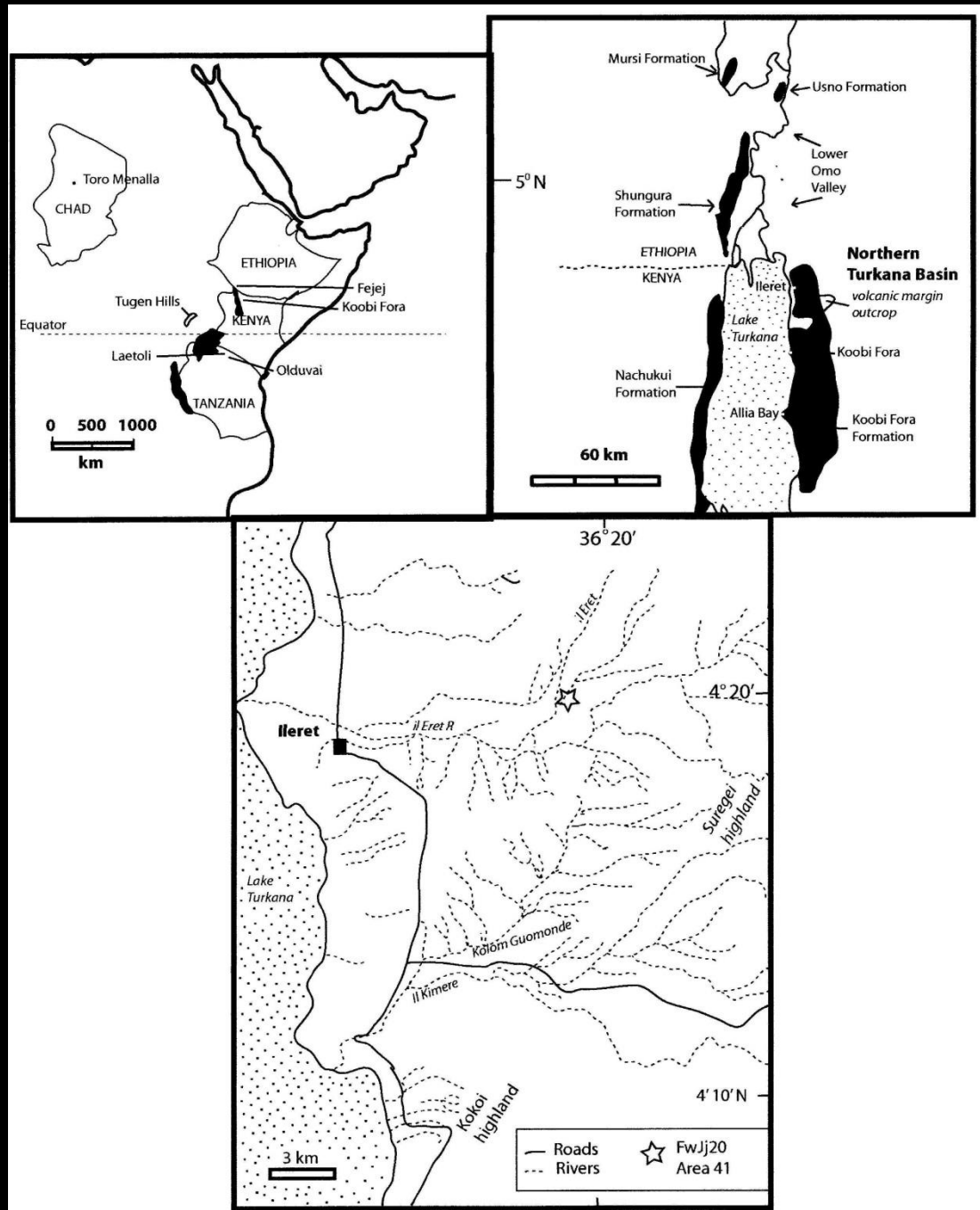
- Increased canopy height on well-drained soils
- Decreased tree cover on poorly drained soils
- Increase in *Acacia* species; increase in species diversity along rivers

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

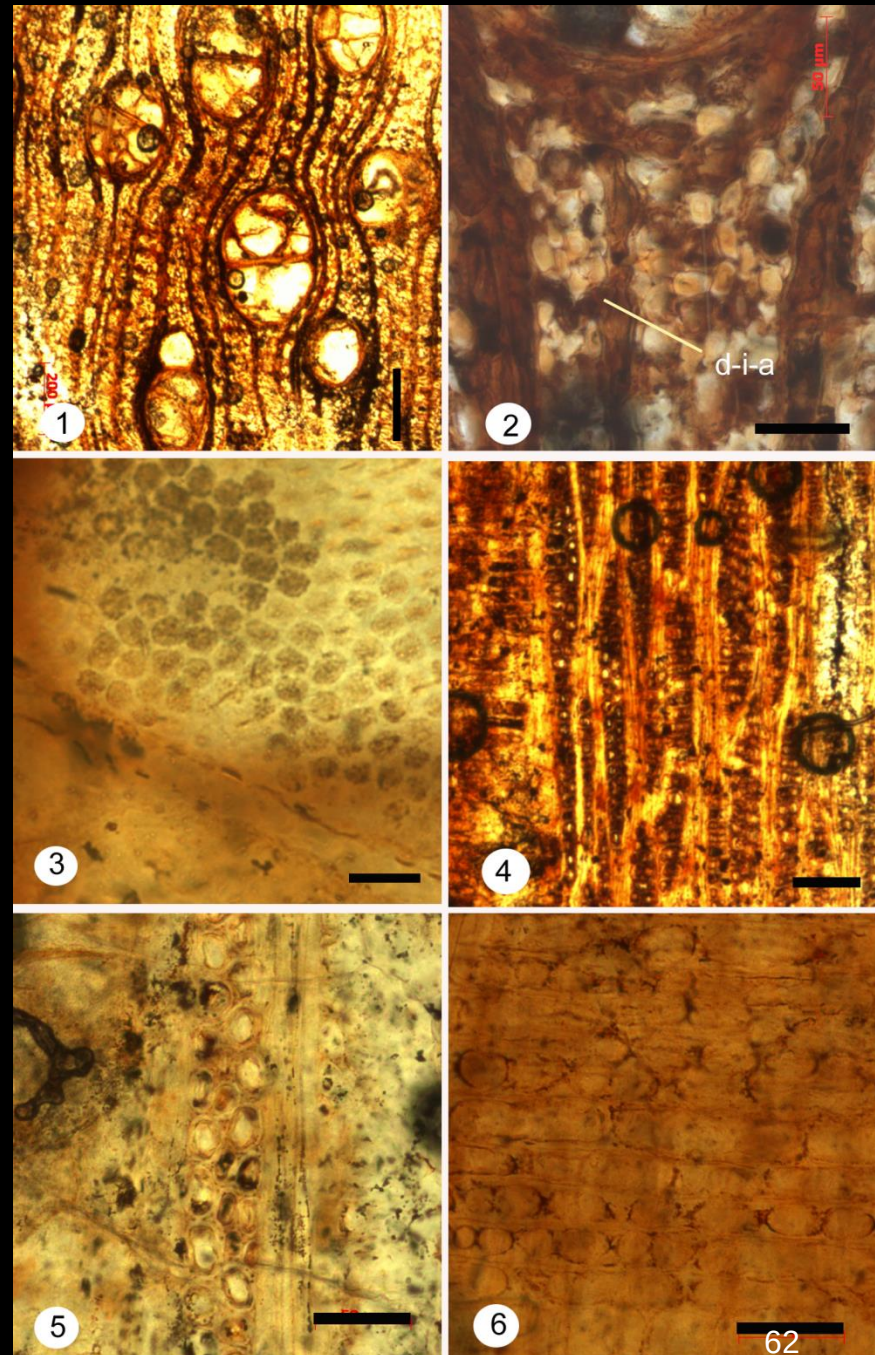


Site FxJj20, Area 41; upper Burgi Member

Apocynaceae
Funtumia sp.
KF009

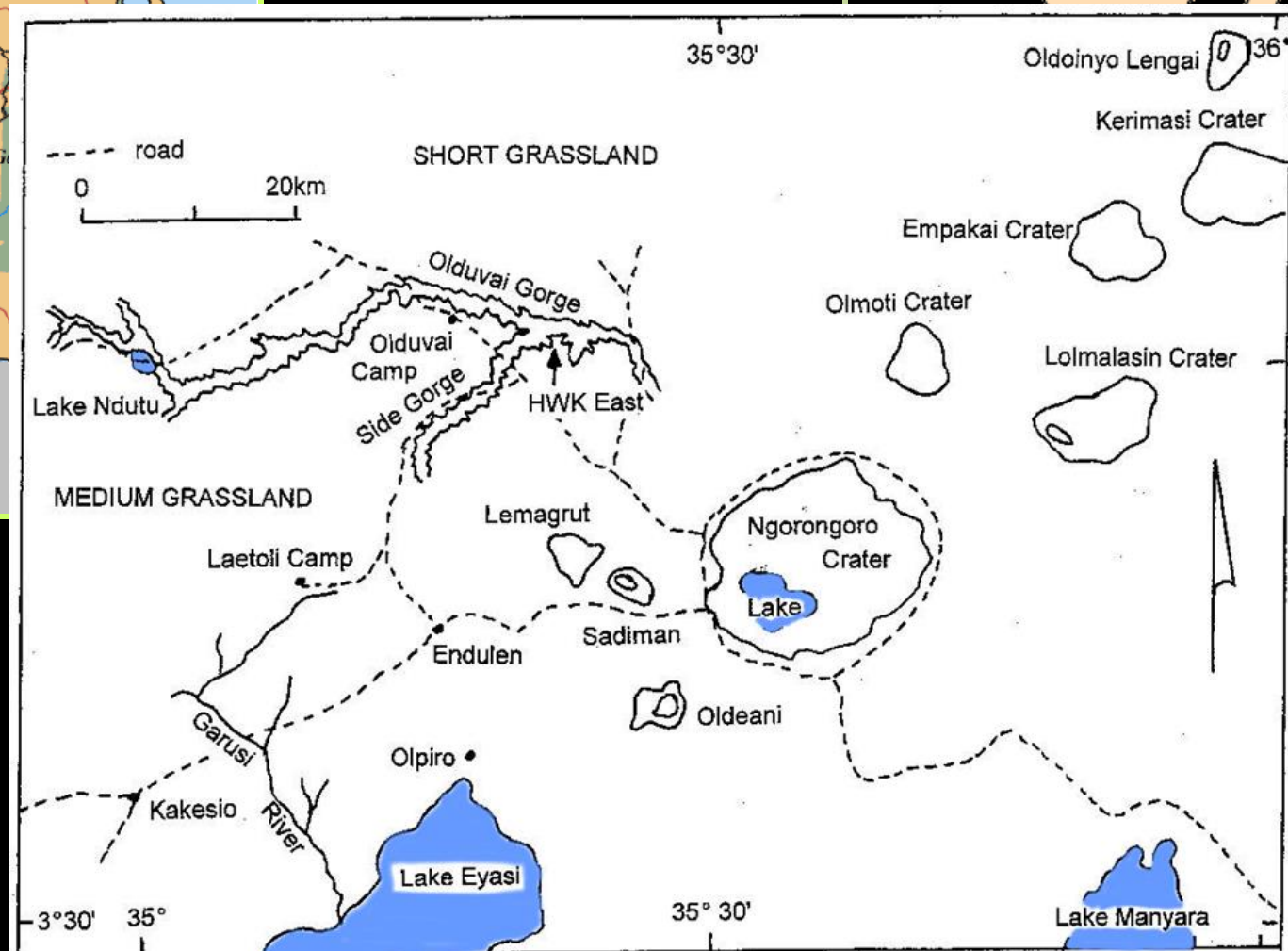
indicates groundwater
forest
butchery site of
mammals, fish,
crocodiles

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



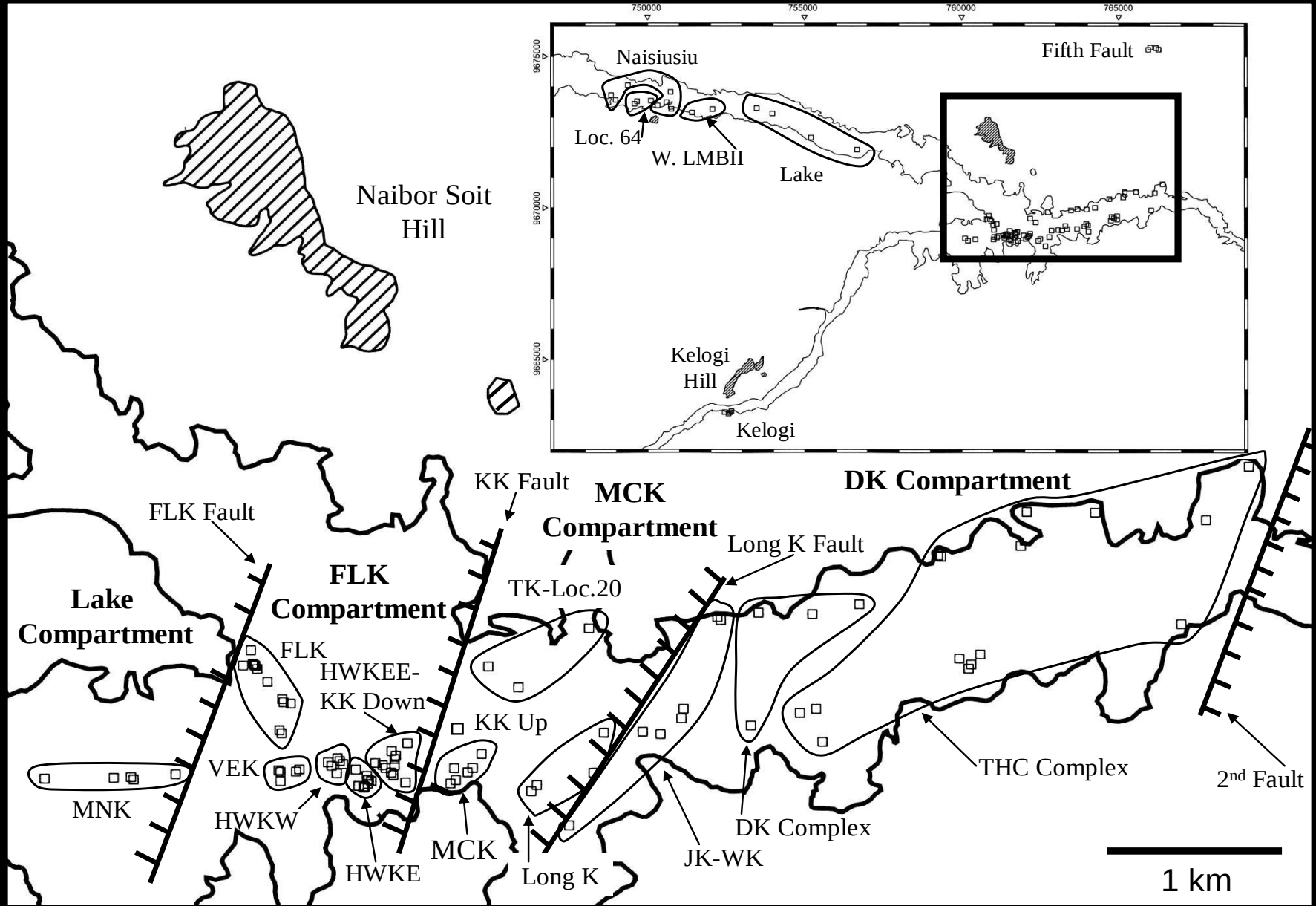
Olduvai Gorge from Second Fault

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

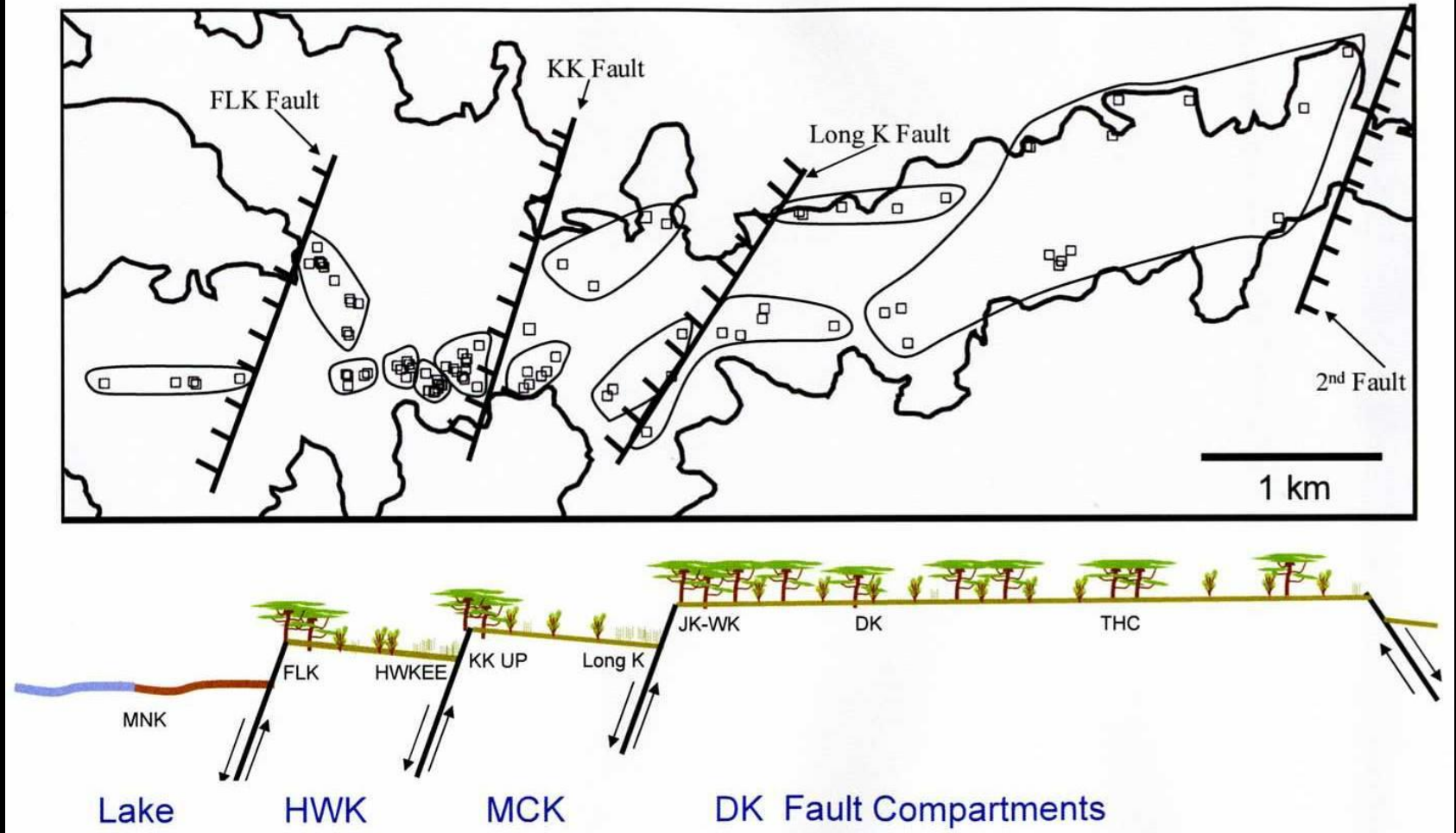


OLAPP – 1. model of landscape ecology (hazards and affordances)



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

Fault Compartmentalization, Pre-Incisional LMBII Eastern Basin



(topography, water, food locations)



OLAPP – 3. Test and refine the model
(geotrenches, concentrations/types of lithics, bones, plants)



Materials and Methods

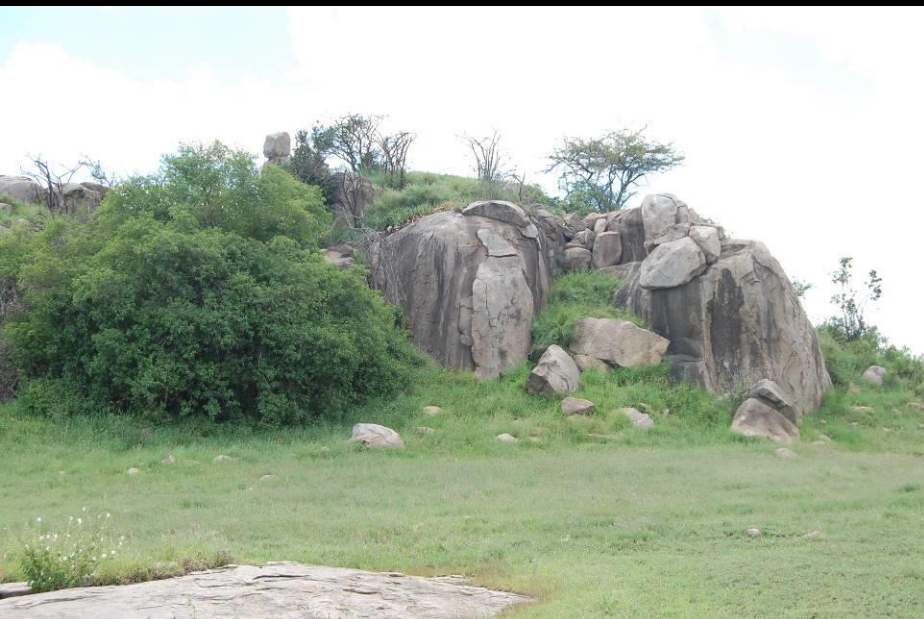
a. Observation,
b. Site selection
c. Reference
collection





Ngorongoro Crater: Ngoitokitok forest-marsh transition

Serengeti



Open woodlands

Riverine
woodlands

Open grasslands

Kopjies

Lake Manyara



Okavango Delta



Seekoeivlei Nature Reserve



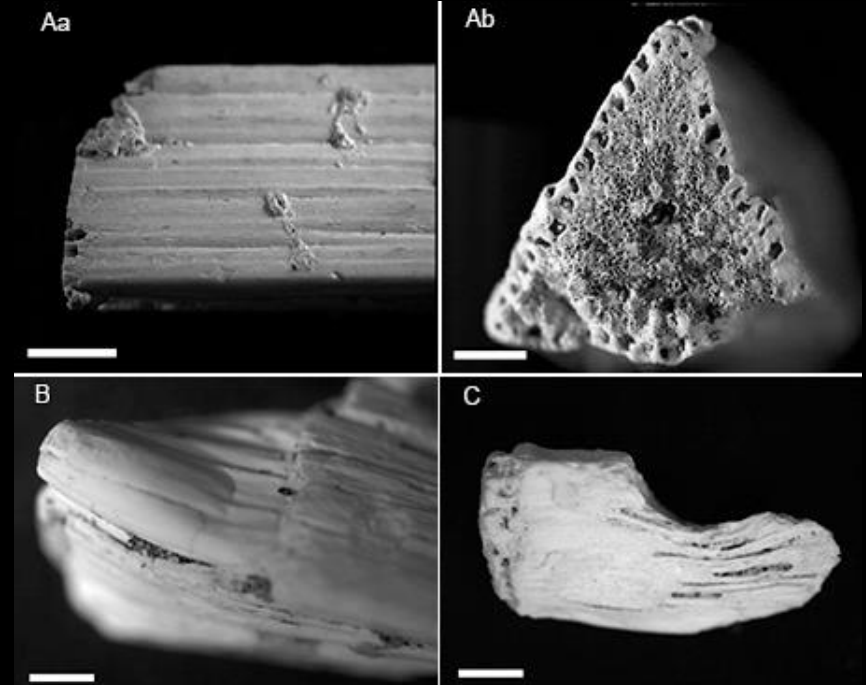
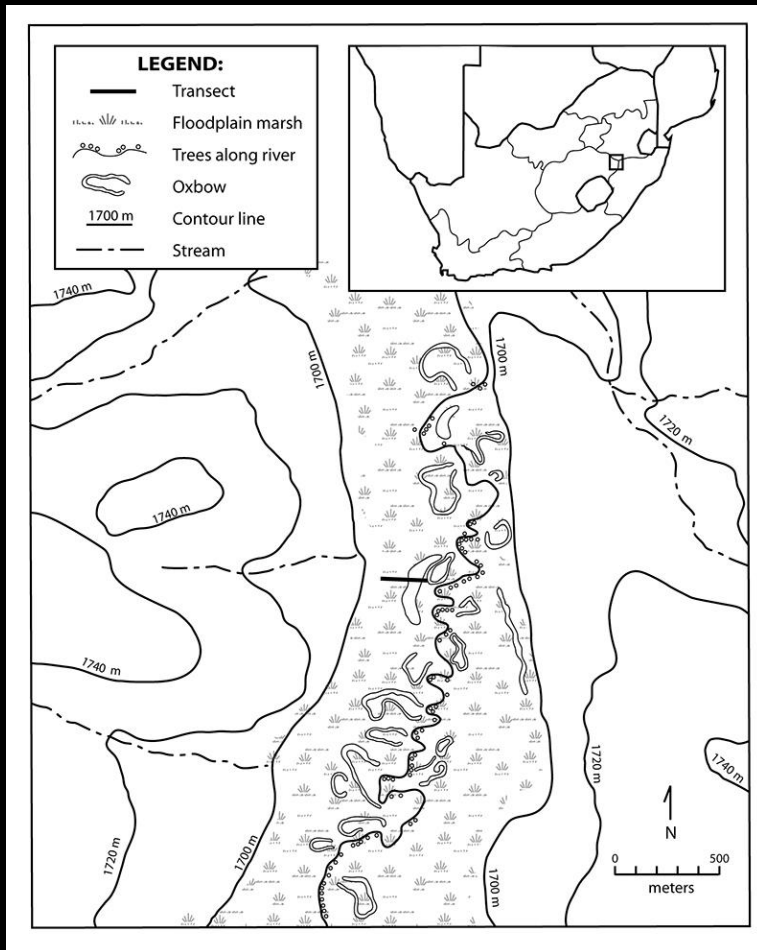
High altitude

Fresh water

Mixed grasses and sedges

Large mammals

Seekoeivlei wetland taphonomy

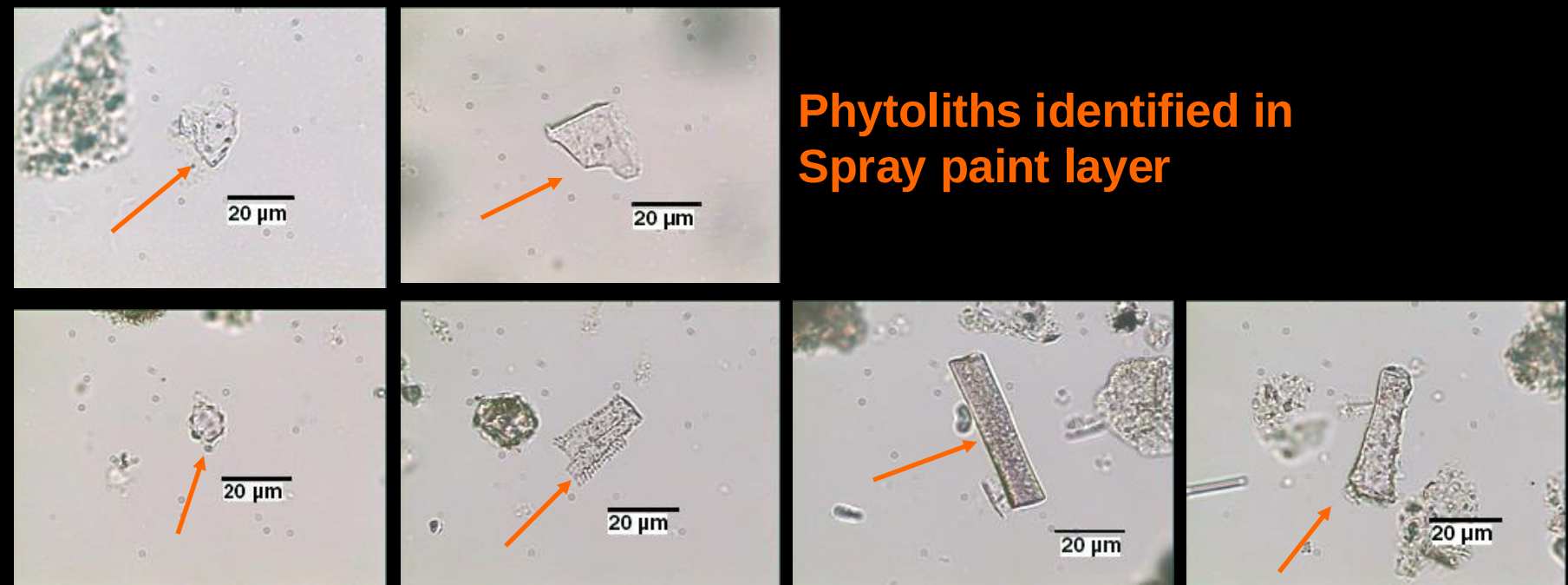


Weathering signatures;
trampling, insect damage

**Phytoliths
identified in T-107.2**



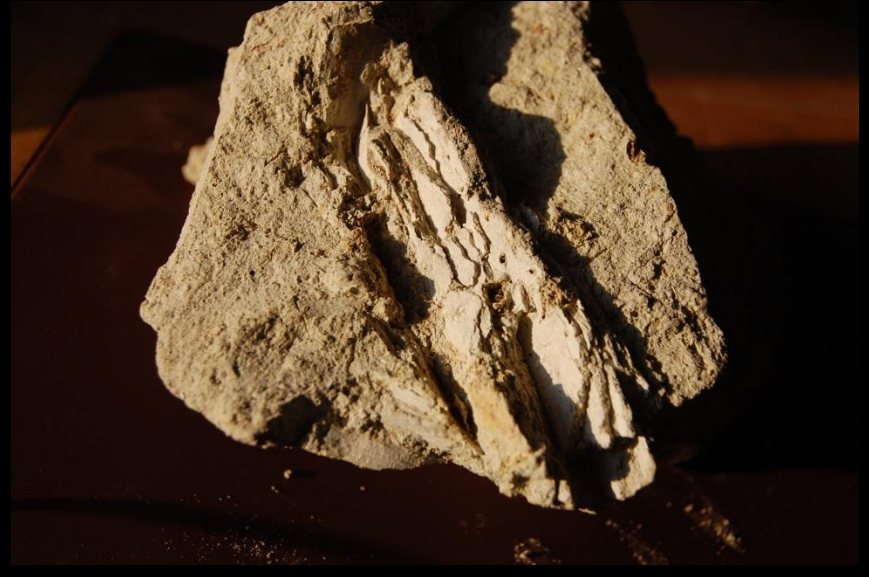
**Phytoliths identified in
Spray paint layer**



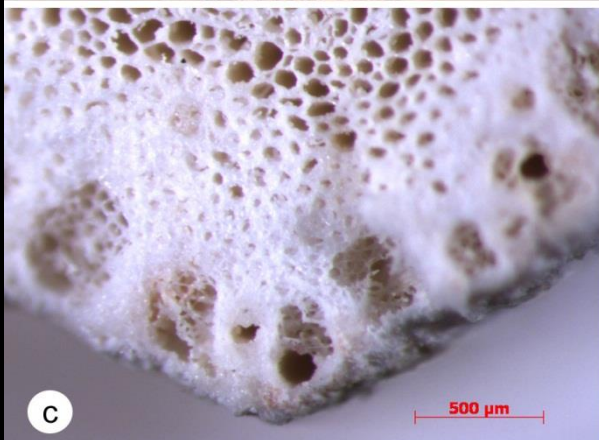
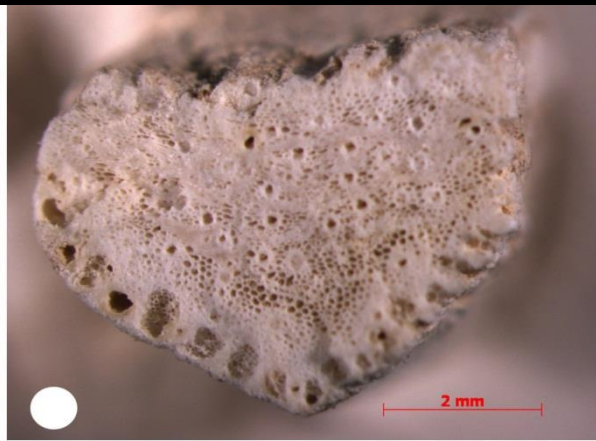
**Fossil
evidence**



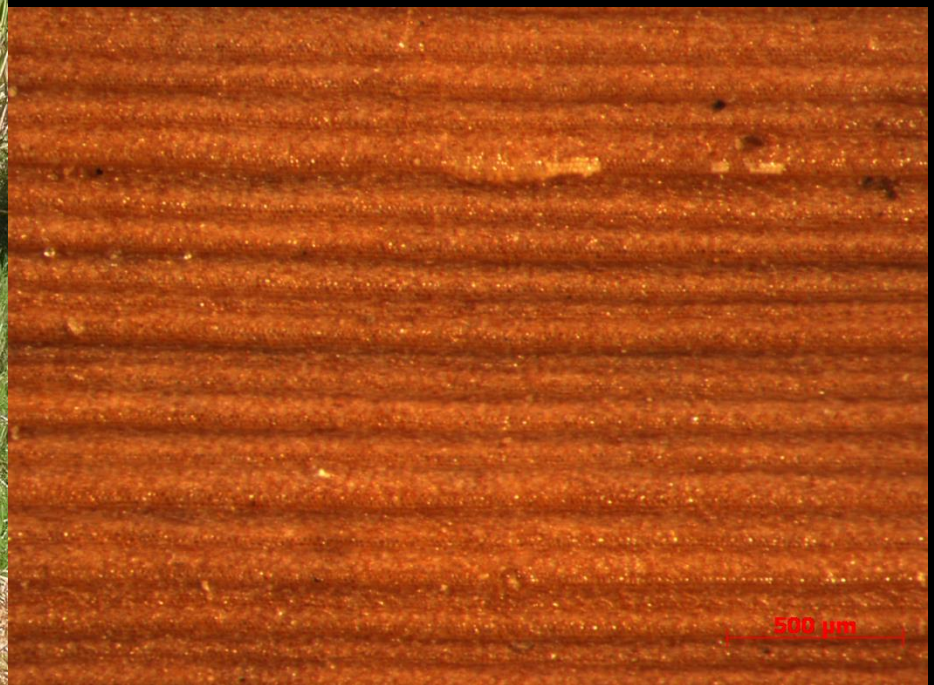
Palms



Sedge: *Cyperus* *sp.*



Typha sp.



Woody twigs



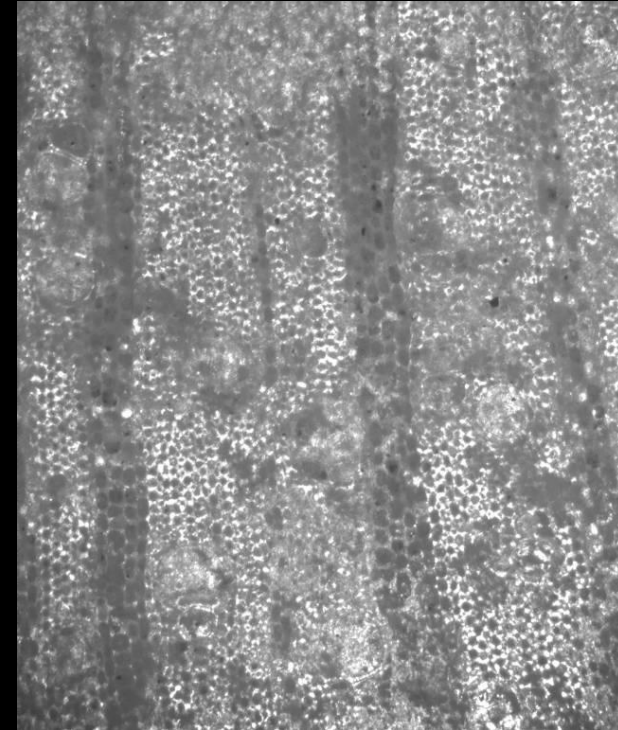
Silicified wood – *Guibourtia coleosperma*



ts



tls



Ts – unidentified dicot wood

~ LMBII, HWKE
Caesalpiniaceae
Large shady tree
Southern distribution

Bamford 2005

Grassland below Tuff IF



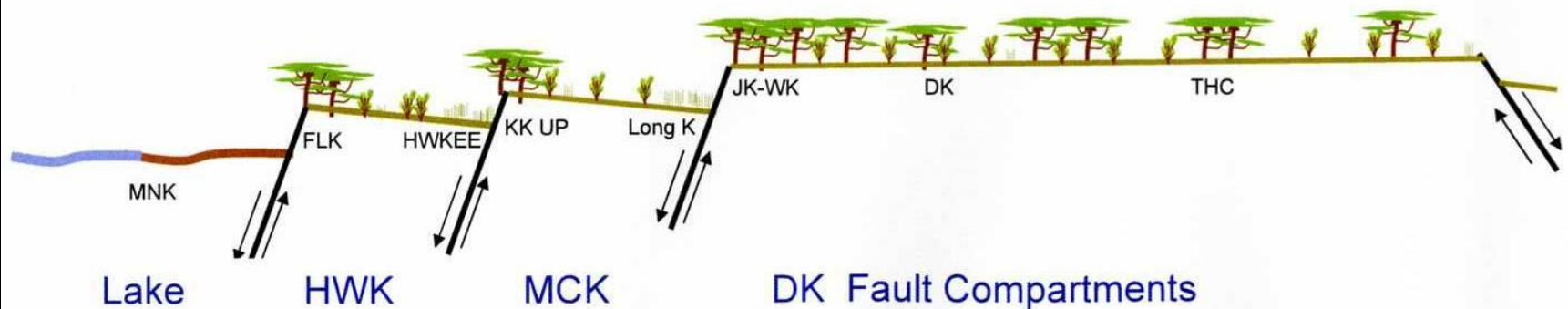
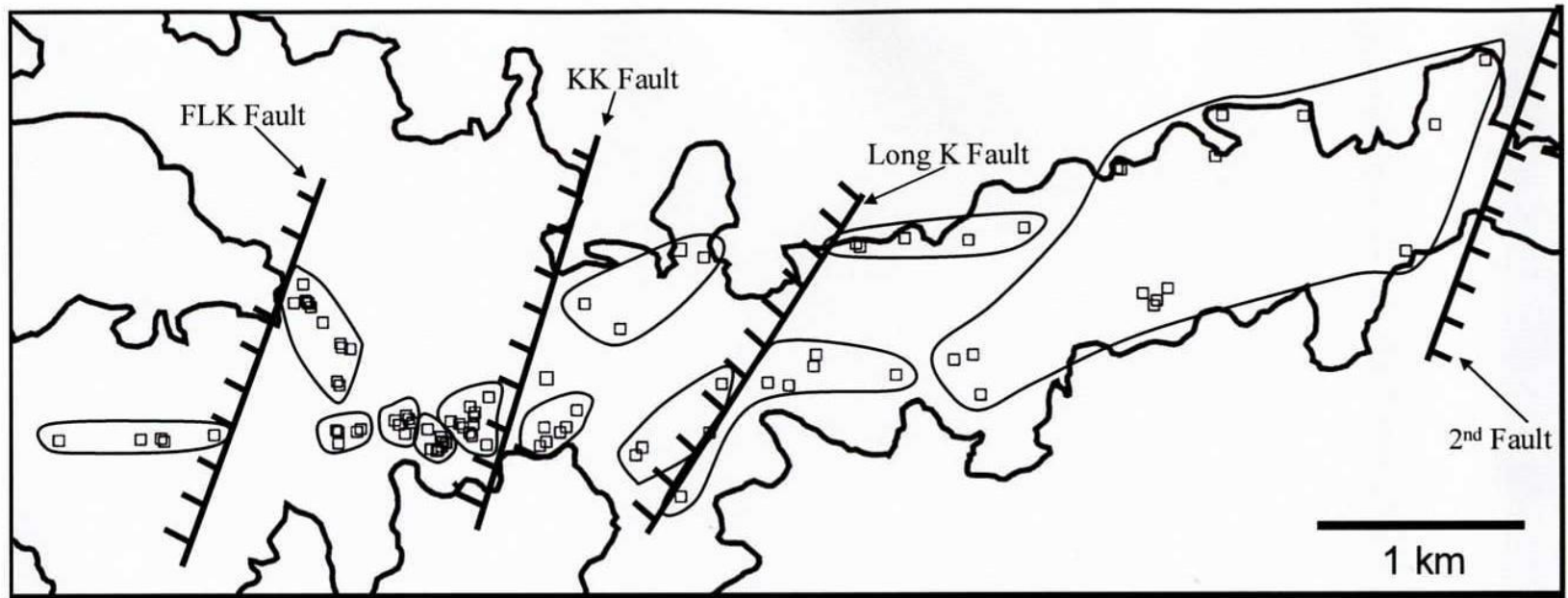
Bamford et al., 2008

Grass culm

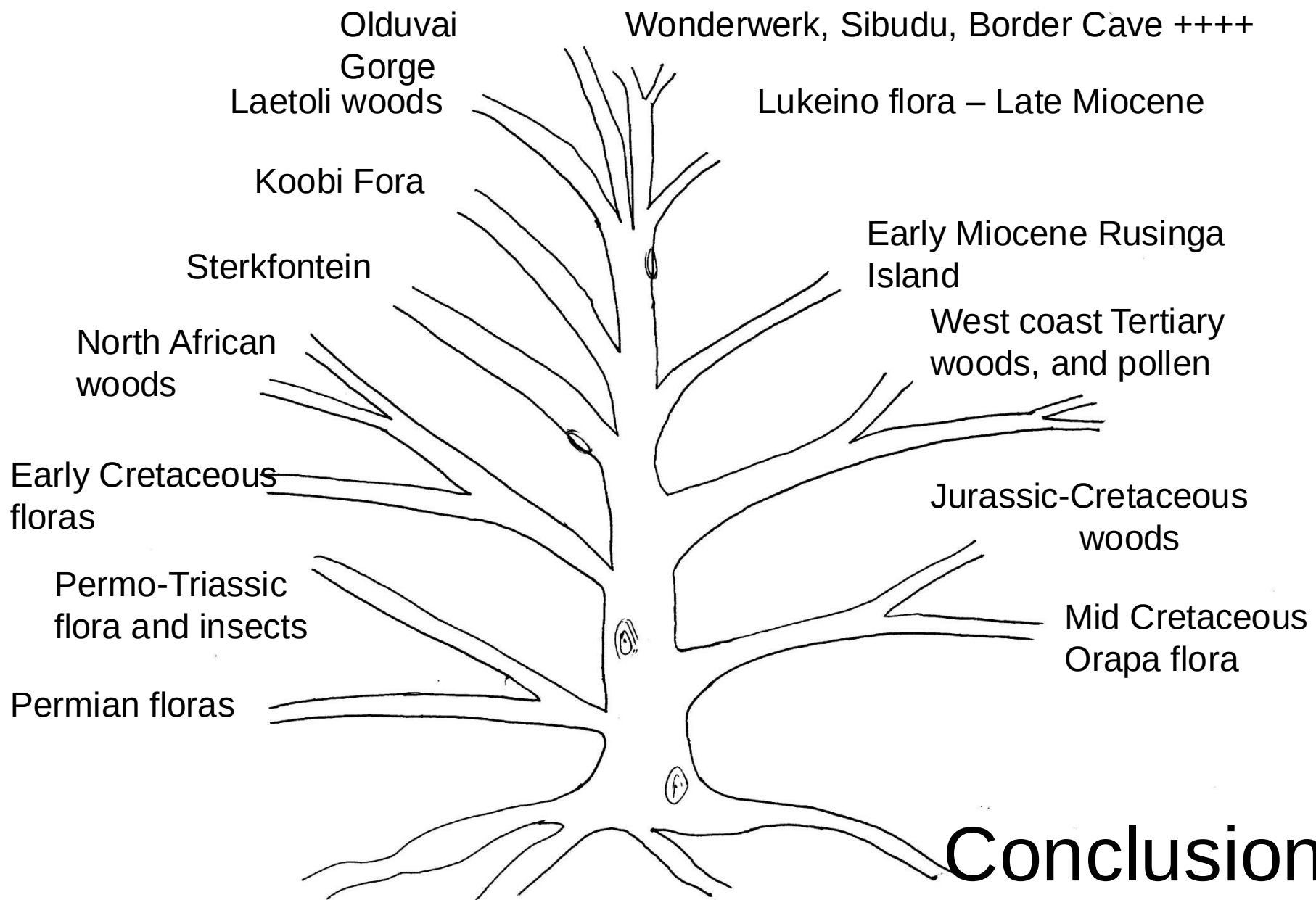
MCK: Tr 108 surf



Fault Compartmentalization, Pre-Incisional LMBII Eastern Basin



Is the model correct?



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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