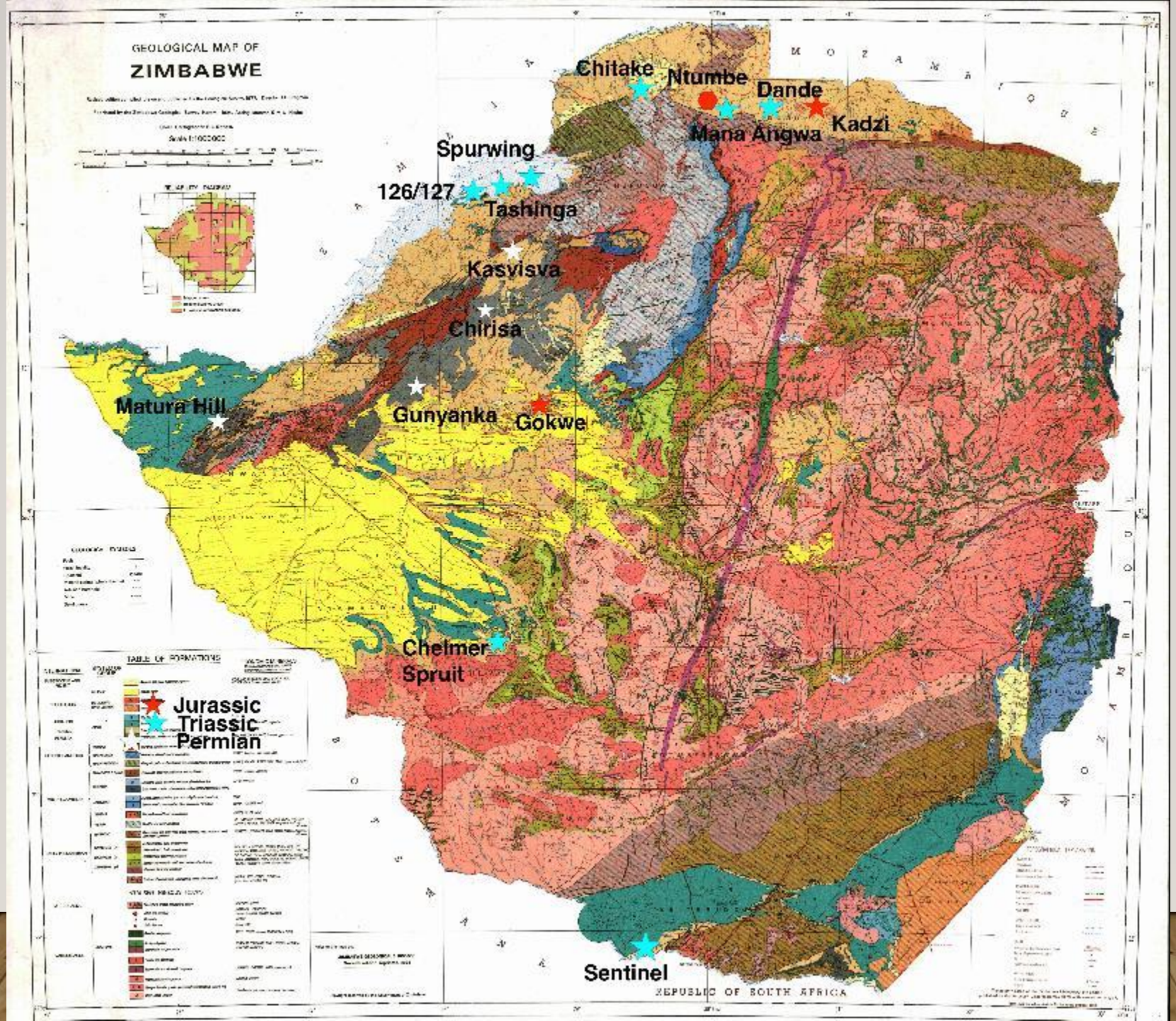
‘DEM BONES’, ‘DEM BONES’ – ZIM MAKES PALAEO-HISTORY A REVIEW

TIM BRODERICK

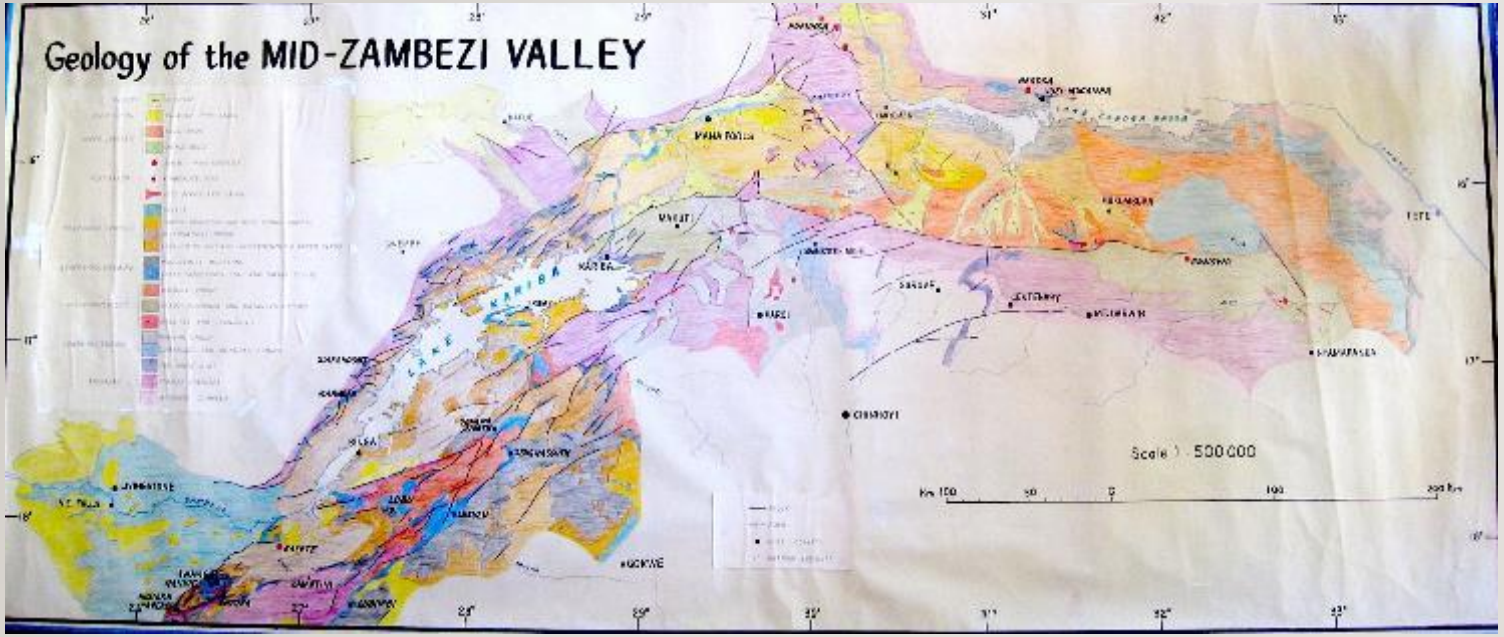
GEOLOGICAL SOCIETY OF ZIMBABWE – SUMMER SYMPOSIUM

21 OCTOBER 2022

HARARE

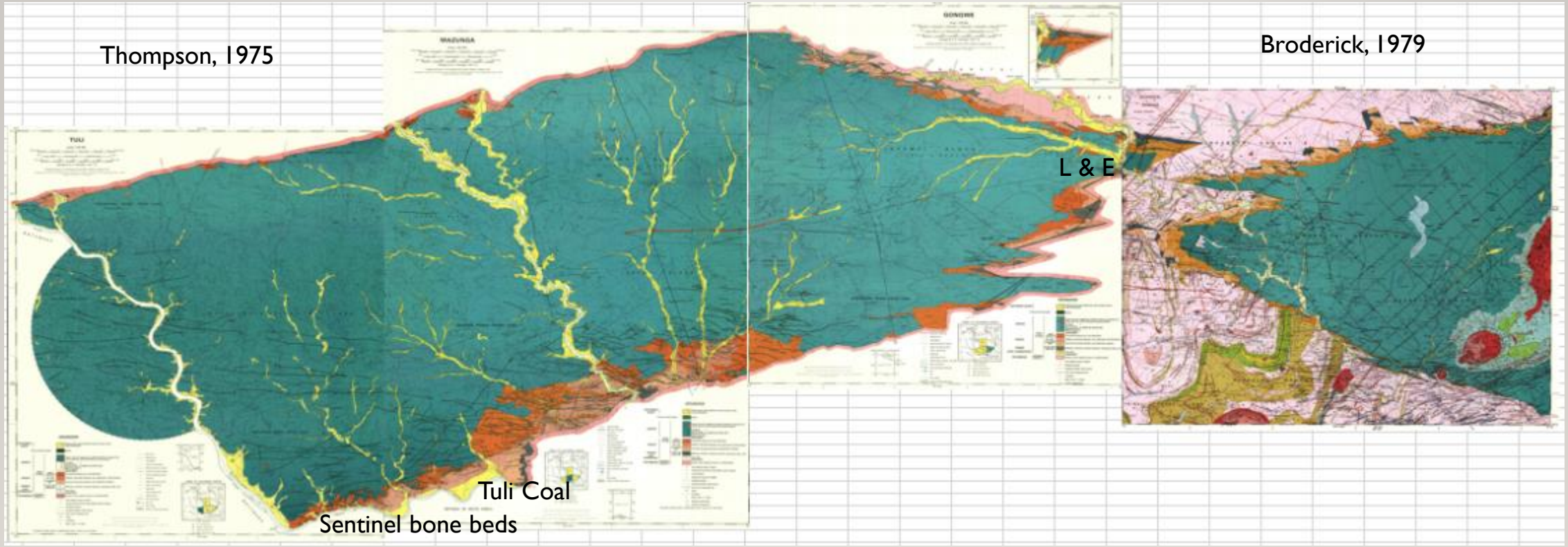

GEOLOGICAL MAP OF
ZIMBABWE
Chitake
Ntumbe
Dande
Kadzi
Mana Angwa
Spurwing
126/127
Tashinga
Kasvisva
Chirisa
Matura Hill
Gunyanka
Gokwe
Chelmer
Spruit
Jurassic
Triassic
Permian
Sentinel
REPUBLIC OF SOUTH AFRICA

Geological interpretation of the Mid-Zambezi, Mana Pools and Cabora Bassa basins (Broderick, 1987)

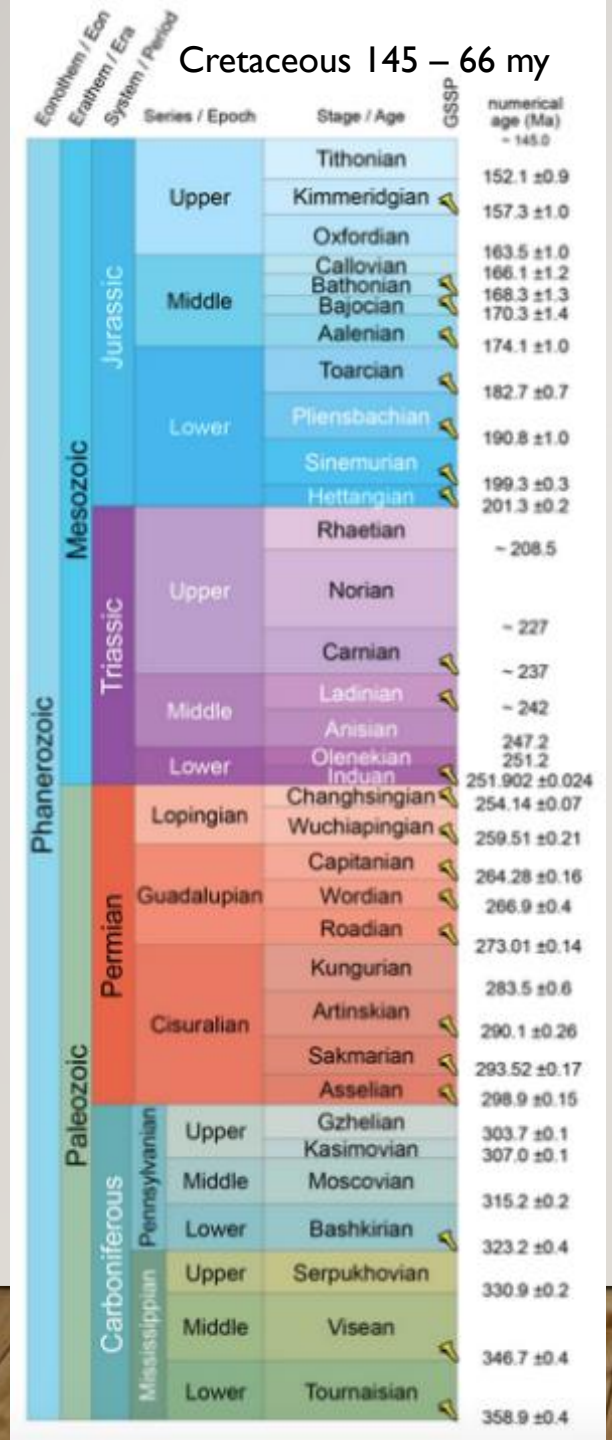


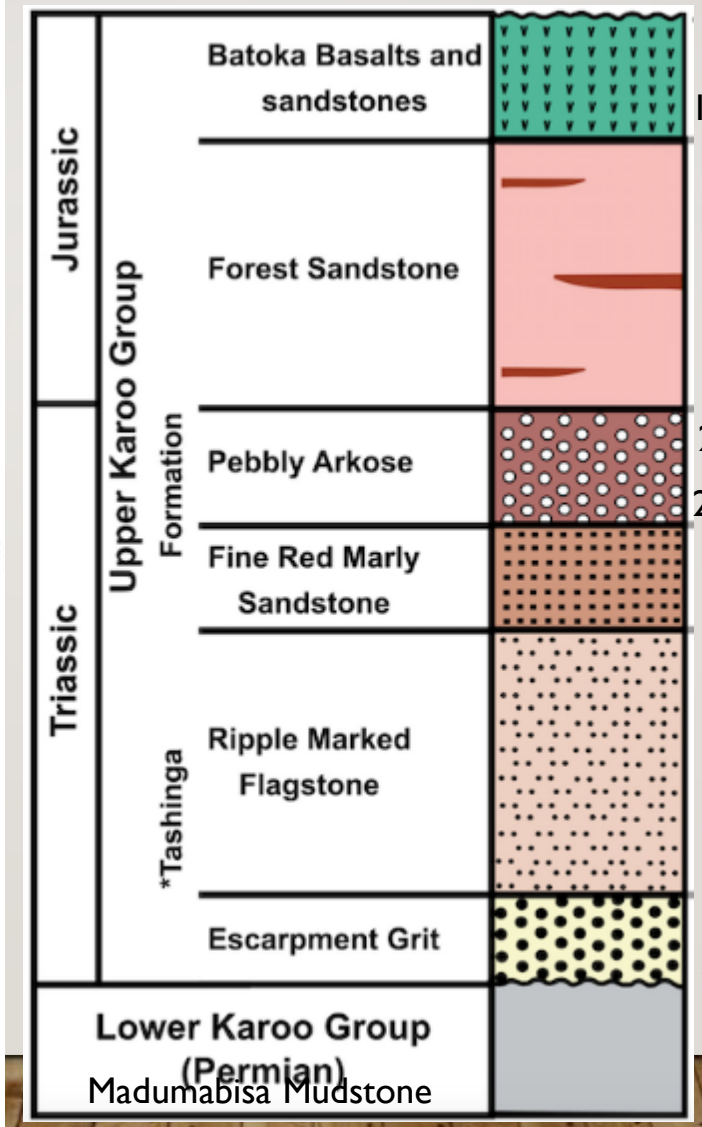
Landsat Image – Mana Pools Basin and Chenje Sub-basin

The Tuli Basin and Nuanetsi Syncline, Zimbabwe



International Chronostratigraphic Chart 2022
www.stratigraphy.org





Mid-Zambezi Basin

Gokwe Formation

145my

180my

206my

230my

250my

300my

Cabora Bassa Basin

Dande Formation

(Jerama Basalt)

Forest Sandstone

Pebbly Arkose

Angwa (alternations)

Angwa Sandstone

Mkanga Fm

Tuli Basin

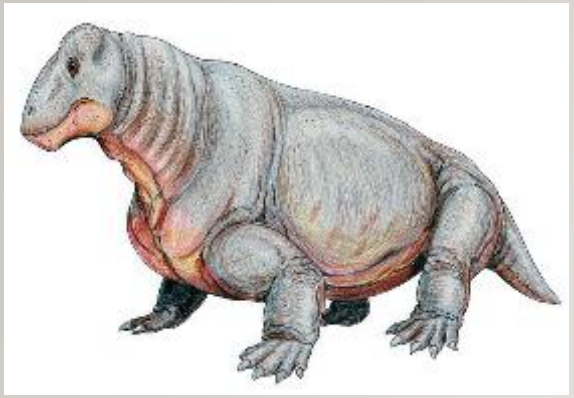
Tuli Basalt

Mpande Fm

Gushu Fm

Fulton's Drift Mudstone

PERMIAN (Lower Karoo Group), Middle Madumabisa Mudstone, k5c & d



Tapinocephalus Zone (k5c) – Dinocephalia - Matura Hill, Hwange; Gunyanka's Kraal, Sebungwe; Simchembu, Sengwa Coal Locality

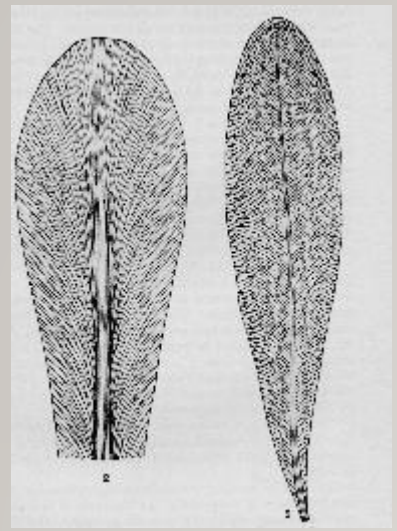
Endothiodon Zone (k5d)
Captorhinid (beak) - Chirisa;
Dicynodont - Chidoma Hill; Kasvisva, Omay.

Dicynodont – 'Two Dog Teeth'

Previously referred to as 'Mammal-like Reptiles' or Stem Mammals. Most died out at the End-Permian extinction, but some such as burrowing dicynodonts came through.

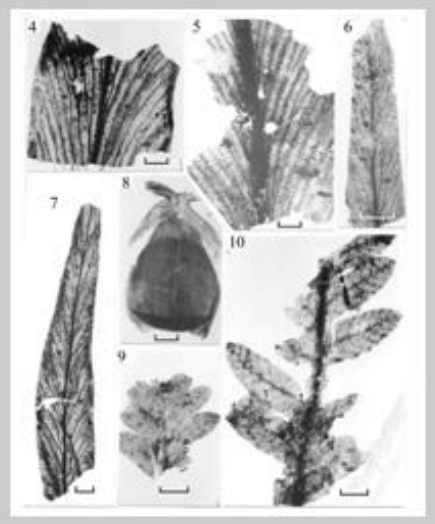
A fossil peat deposit from the Late Triassic (Carnian) of Zimbabwe with preserved cuticle
of Pteridospermopsida and Ginkgoales, and its geological setting

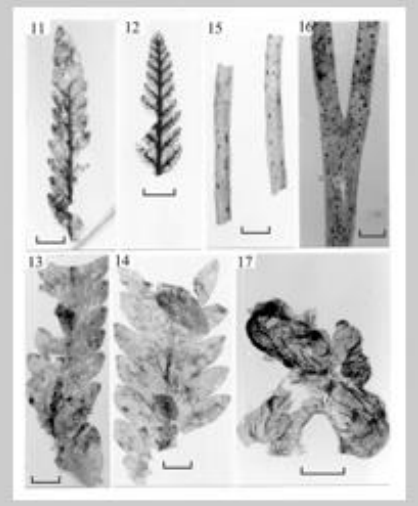
Georges Barale, Marion K. Bamford, Bernard Gomez, Timothy J. Broderick, Michael A. Raath & Ann Cadman



Permian
Glossopteris Flora
1. *Gangamopteris*
2. *Glossopteris*
Hwange; Lubimbi; Lusulu; Sengwa; Mkanga; Tuli

The Manyima Fossil Plants

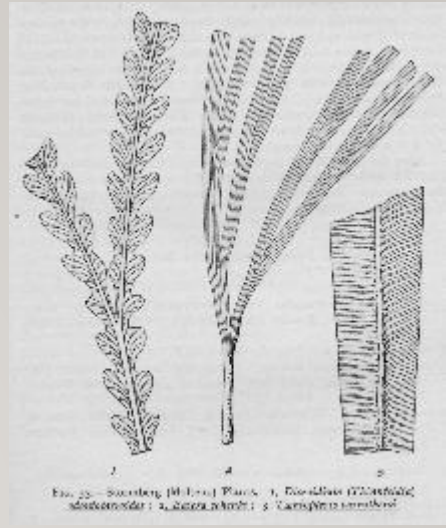




Detail of *Dicroidium*, *Lepidopteris* and *Sphenobaira* sp.

A typical plant assemblage that places the Angwa Sandstone into the Early Triassic. Showing remarkable preservation in a fossil peat deposit, these seed ferns, ferns and gingoales are transparent and flexible.

Palaeont. afr. (December 2005) **41**: 89–100



Triassic
Dicroidium Flora
1. *Dicroidium*
2. *Sphenobaira*
3. *Taeniopteris*
Mucheni R.; Manyima R.; Somabhula Diamond Fields

Fossil Wood has been found from the Permian Madumabisa Mudstone north of Gokwe. It is most commonly found associated with the Upper Karoo Pebbly Arkose, but can be found elsewhere in the stratigraphic column such as the Forest Sandstone.

Known from Detema, Hwange NP; Gokwe; Matusadonha NP; Bumi; Chewore; Dande (nr Chapoto Fly Gate); Gokwe; Somabuhla and Mhondoro.

Tree trunk casts in Forest Sandstone, Nyamembere Island with associated silicified rhizoliths as exposed by wave action.
Tim Broderick

Fossil wood near Bumi.
Steve Edwards.

Fossil wood upstream near Ume River, Mola area.
Ken Worsley

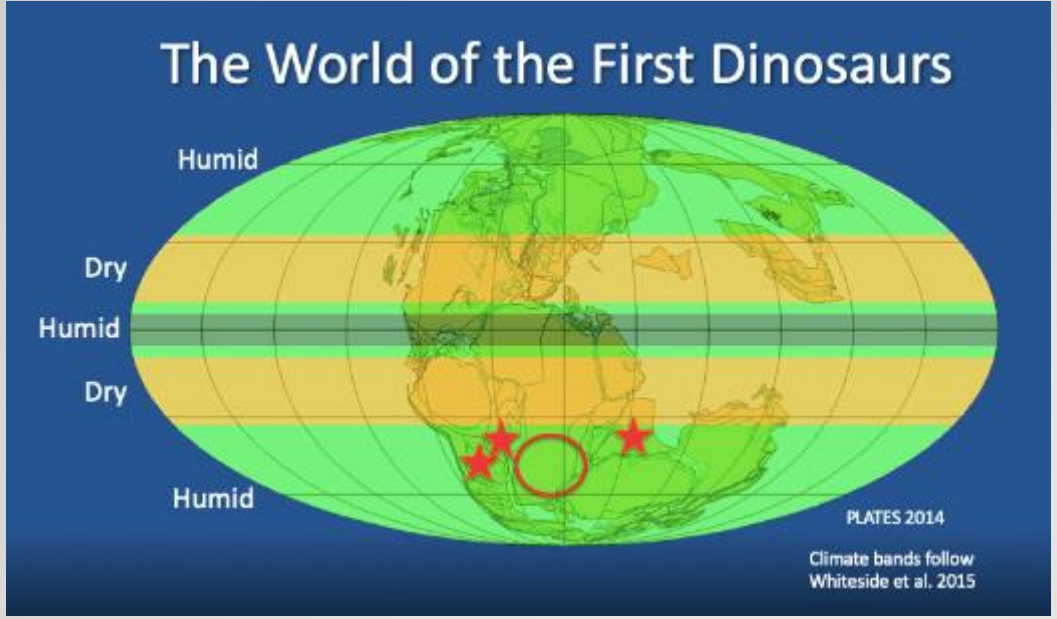
Dadoxylon sp.
Rhexoxylon sp.

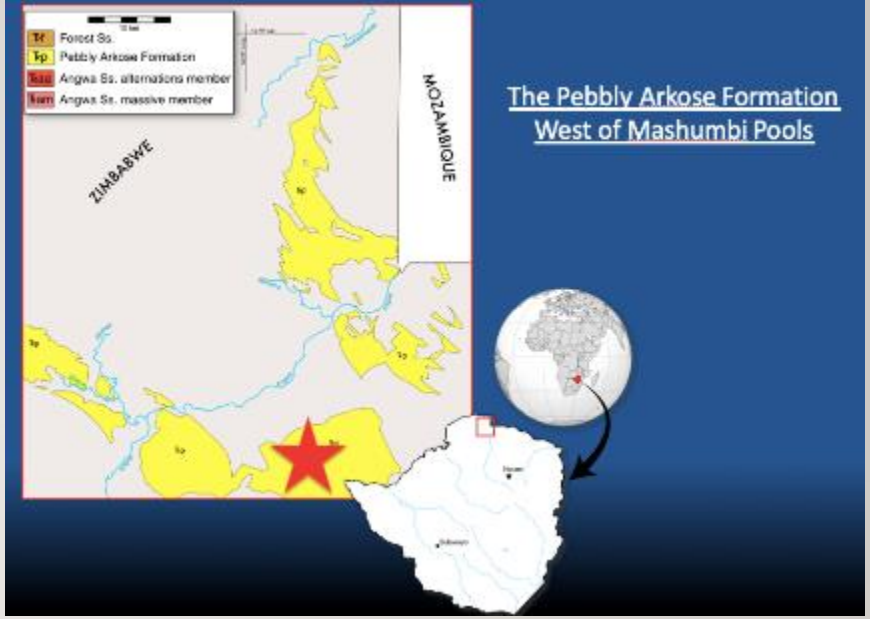
Chris Griffin
Virginia Tech

Dande 2017-2019

NATIONAL GEOGRAPHIC

The National Museums and Monuments of Zimbabwe

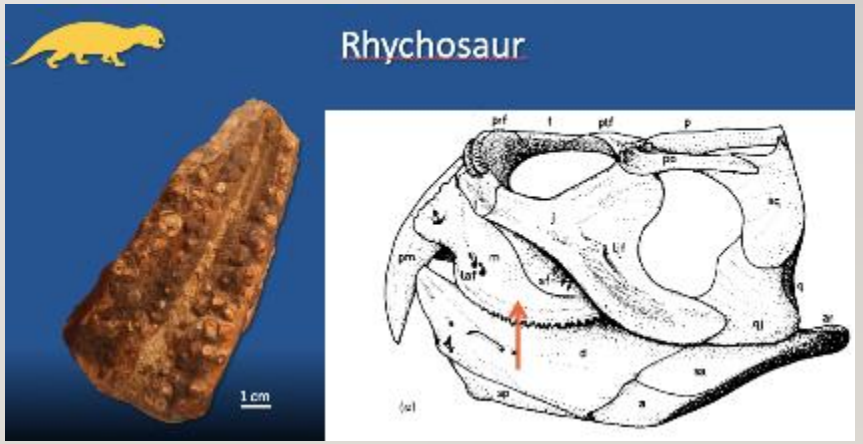




Whilst mapping the geology south of Kanyemba, Philip Oesterlen found strange teeth and bone. We photostated the material and posted images to Mike Raath at Wits. James Kitchen identified it as a Rhynchosaur, and subsequently in 1992 they associated an undoubted sauropodomorph dinosaur femur head. Chris Griffin linked early dinosaur discoveries in Brazil, Argentina and India with a reconstructed Pangaea and palaeoclimate bands to focus on the Dande area where 230 my-old (Carnian age) sediments were expected to have been deposited

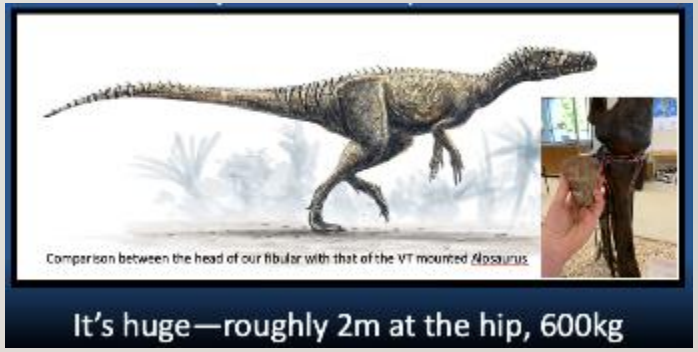
A hatchet-shaped muscle scar is a classic sauropodomorph characteristic.

The dip in the lower lip, another. Dentition – a plant eater



In South America and India they have an association of rhynchosaurs, cynodonts, aetosaurs and herrerasaurid dinosaurs with basal sauropodomorph (*Saturnalia*) remains.

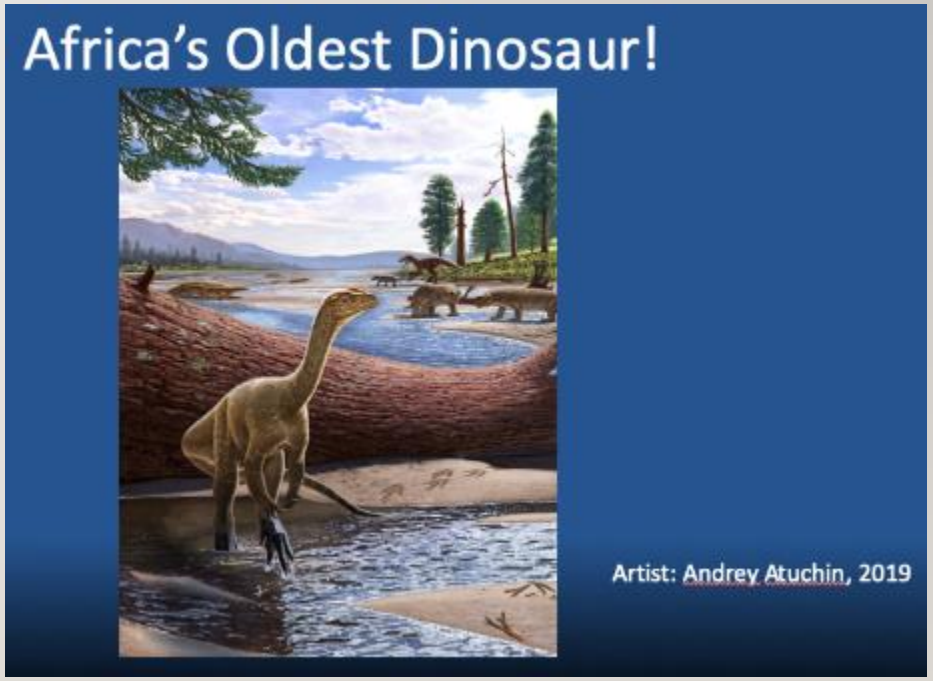
In Zimbabwe we have established the same faunal assemblage in similar aged, 230 my-old sediments to those found in S. America



Our ‘Dinky Dande Dino’, about 0,5m at the hip, turned out to be an almost complete skeleton. Billed as the oldest known dinosaur in Africa (if not the World), it is being christened *Mbiresaurus raathii* in our (imminent) paper to *Nature Magazine*.

"Africa’s oldest dinosaurs reveal early suppression of dinosaurian distribution”

Christopher T. Griffin, Brenen M. Wynd, Darlington Munyikwa, Tim J. Broderick, Michel Zondo, Stephen Tolan, Max C. Langer, Sterling J. Nesbitt, Hazel R. Taruvinga



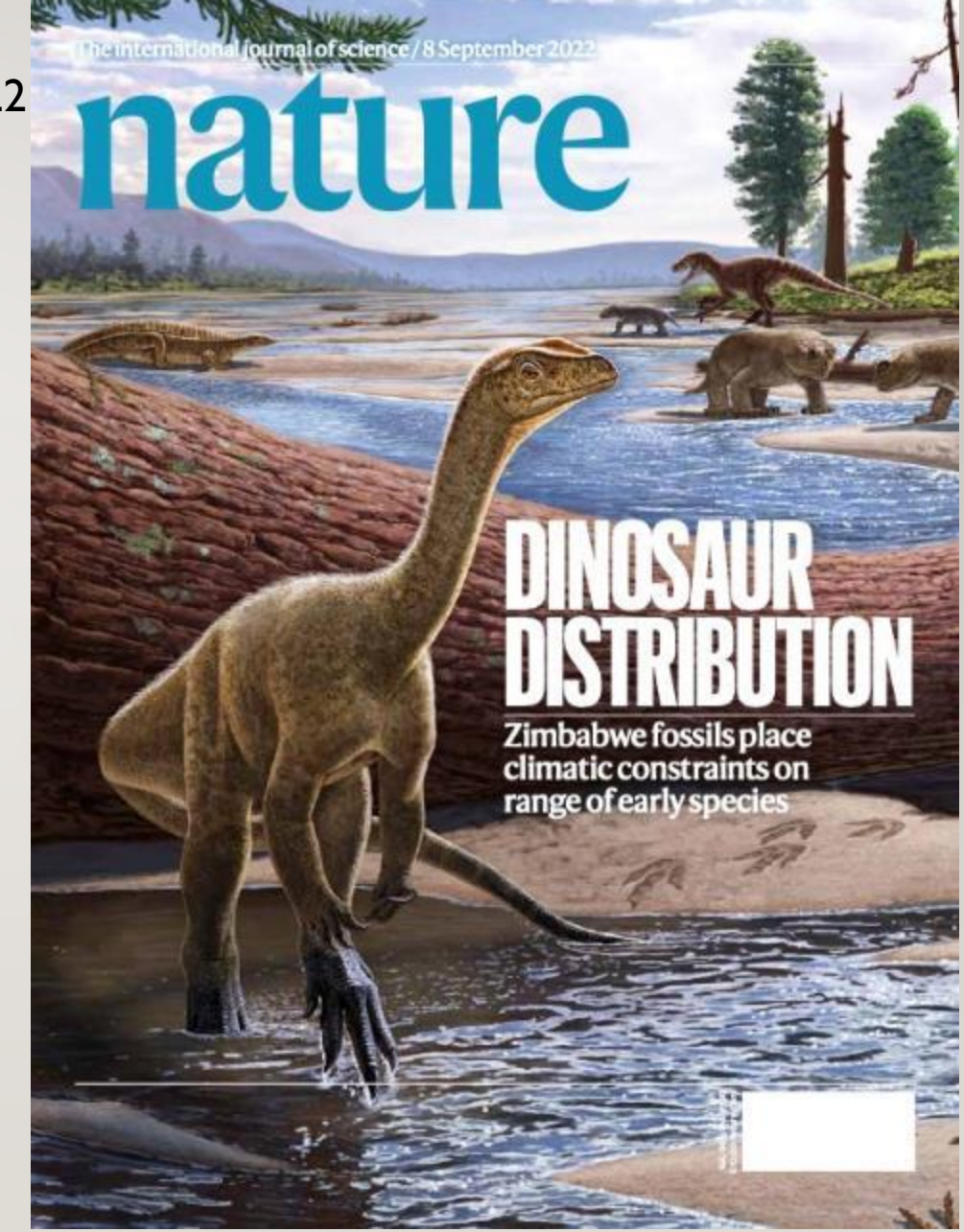
Published! *Nature*, 8th September 2022

Dande Team 2017

Dande Team 2019

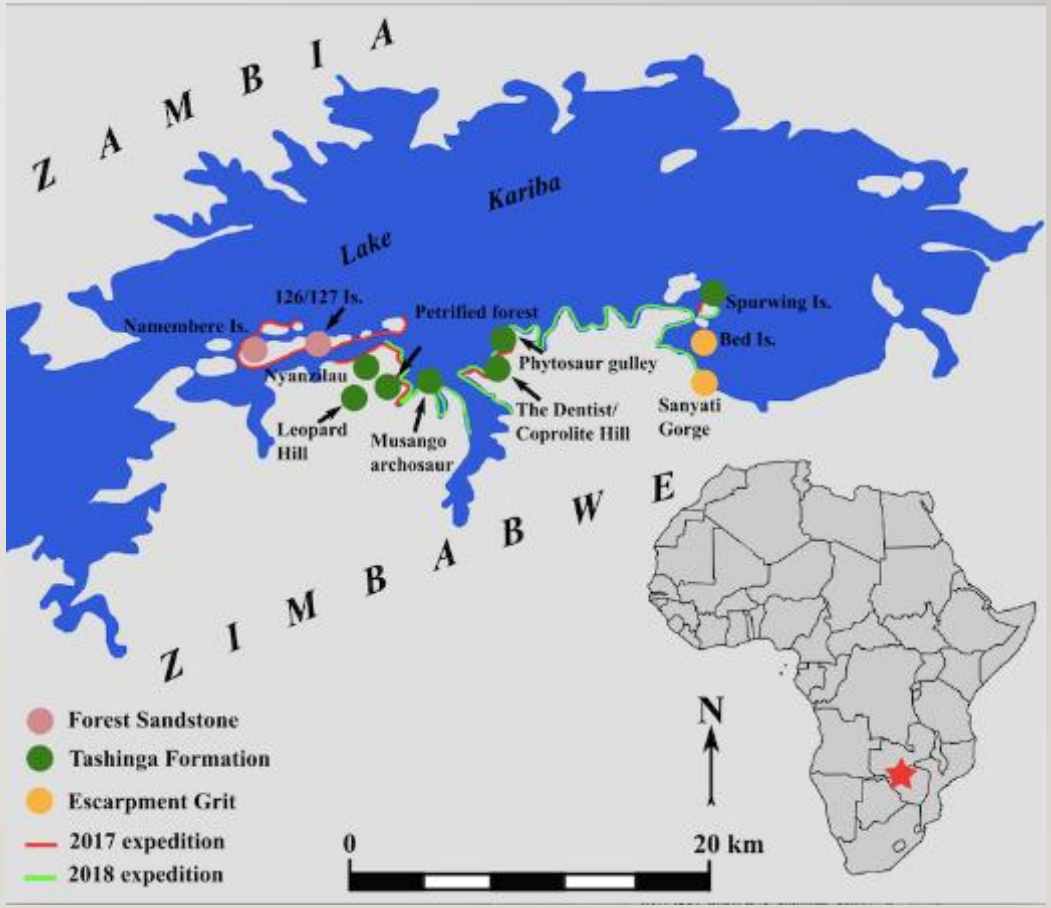
Inset: Sterling Nesbitt

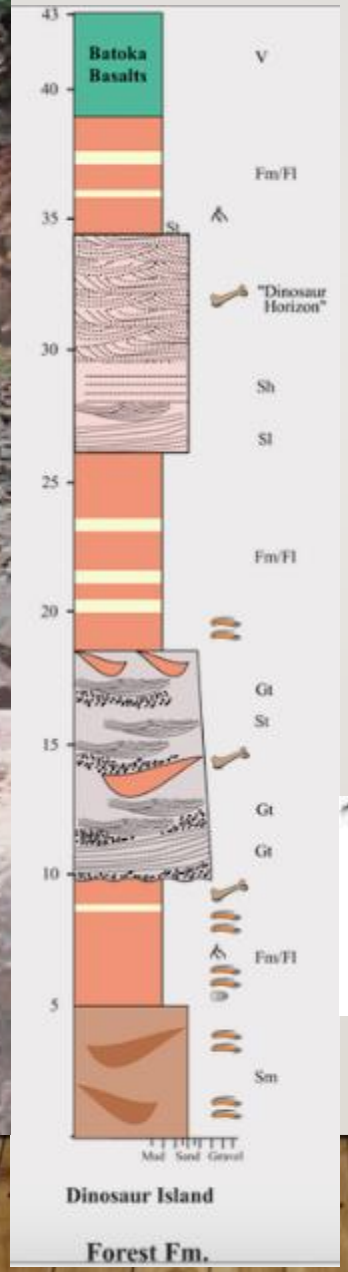
Artist: Andrey Atuchin, 2019



Joint Evolutionary Studies Institute (Wits), Natural History Museum, Kensington and National Museums & Monuments' expeditions to Lake Kariba, 2017 and 2018

Lucy Broderick

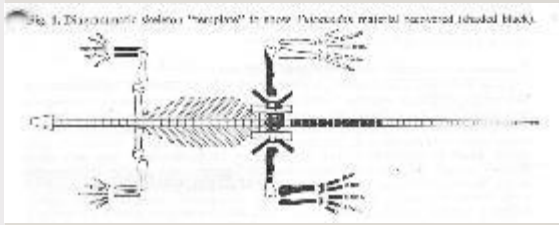




Island 126/127, Sibilobilo

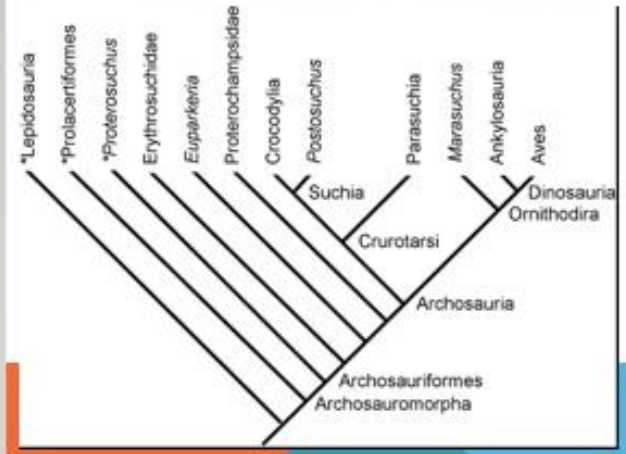
Very little bone material was recovered to enhance our understanding of the Early Jurassic sauropod, *Vulcanodon karibaensis*, described by Mike Raath in 1970, save to say that the stratigraphic column does not indicate its presence between lava flows but within the Forest Sandstone succession beneath. Also, the wider presence of bone material on other islands, as determined by Annie Cheeseman in the 1990's, was confirmed.

Stratigraphy of the Vulcanodon type locality and its implications for regional correlations within the Karoo Supergroup
Viglietti, Pia et al., 2018.
Journal of African Earth Sciences Vol. 137, pp. 149-156



Tashinga Lake Shore

Lucy Broderick



Steve Edwards' bone collection from a grey mudstone facies near Tashinga comprises craniodental material and osteoderms in association with *Ceratodus* (lungfish) dentition indicating a palaeo-feeding frenzy. The deposit Includes associated coprolites. Phytosaurs, as archosaurs, evolved separately towards crocodiles and to dinosaurs and birds in the late Triassic, hence the significance of this find, apart from the fact that it represents the only Phytosaur find south of the Sahara.

Phytosaur

Amphibian scute

Barrett PM et al. 2020. The age of the Tashinga Formation (Karoo Supergroup) in the Mid-Zambezi Basin, Zimbabwe and the first phytosaur from sub-Saharan Africa.
Gondwana Research Vol. 80, pp. 445–60.

Sedimentology and palaeontology of the Upper Karoo Group in the Mid-Zambezi Basin, Zimbabwe: new localities and their implications for interbasinal correlation
Sciscio, Lara et al.
Geological Magazine, Cambridge 2020

Invertebrate and plant trace fossils from the Terrestrial Late Triassic of Zimbabwe
Sciscio, Lara et al.
Palios 2021, Vol. 36, pp. 129–140

Phytosaur coprolites

Bioturbation.
Beaconites isp. burrow

Lara Sciscio

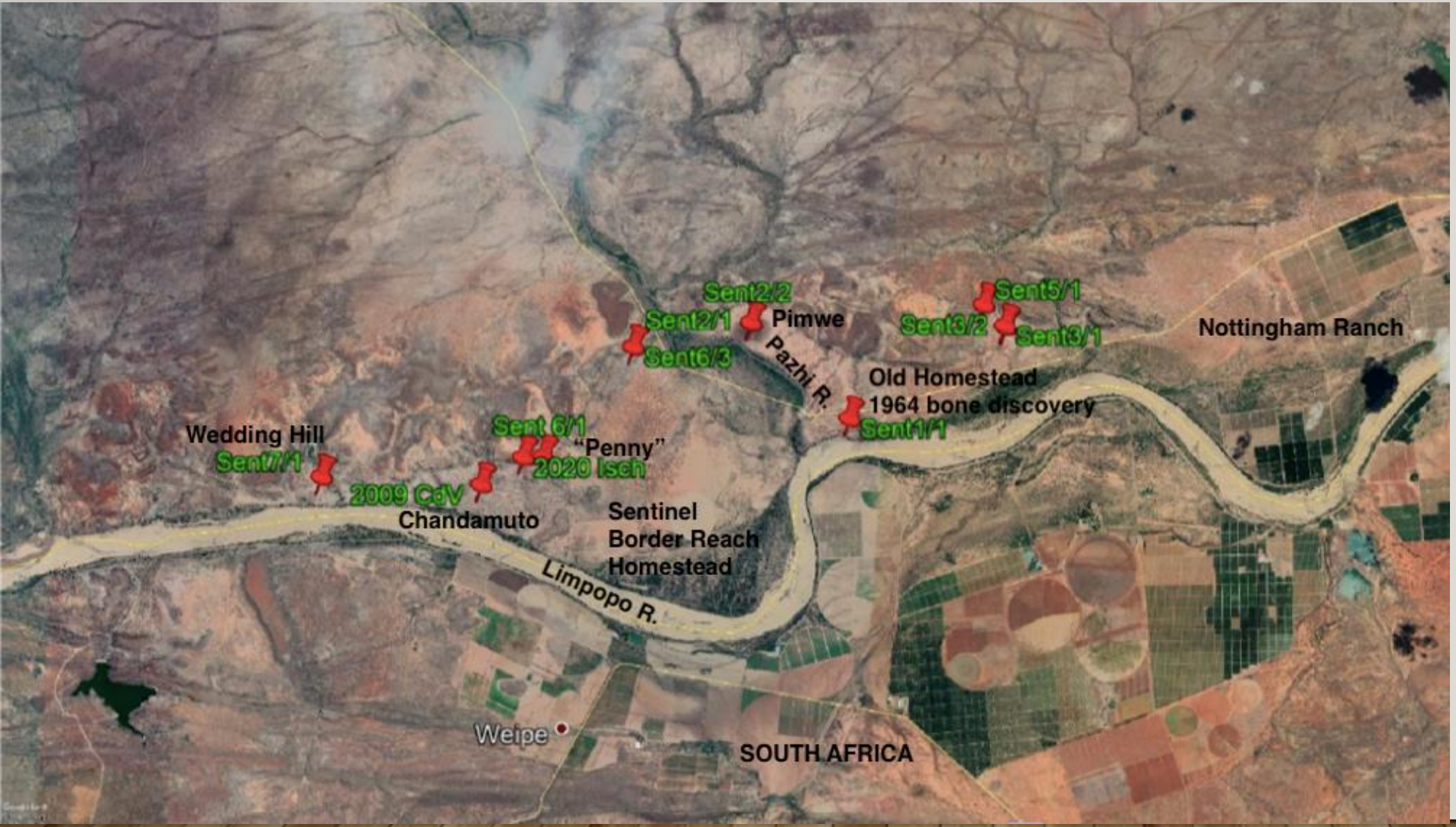
Paul Barrett & Mike Zondo

Jonah Choiniere

Then on farther east we started to find prosauropod dinosaur remains. However, we were chased off after a narrow escape, but the evidence is there for a return exploration trip.

Spurwing Island revealed early sauropodomorph material Including a partially articulated hind limb, which is being described as we speak at the *Palaeontological Society of South Africa* Annual Conference at Golden Gate National Park.

Sentinel Ranch, Beitbridge - Bone Localities

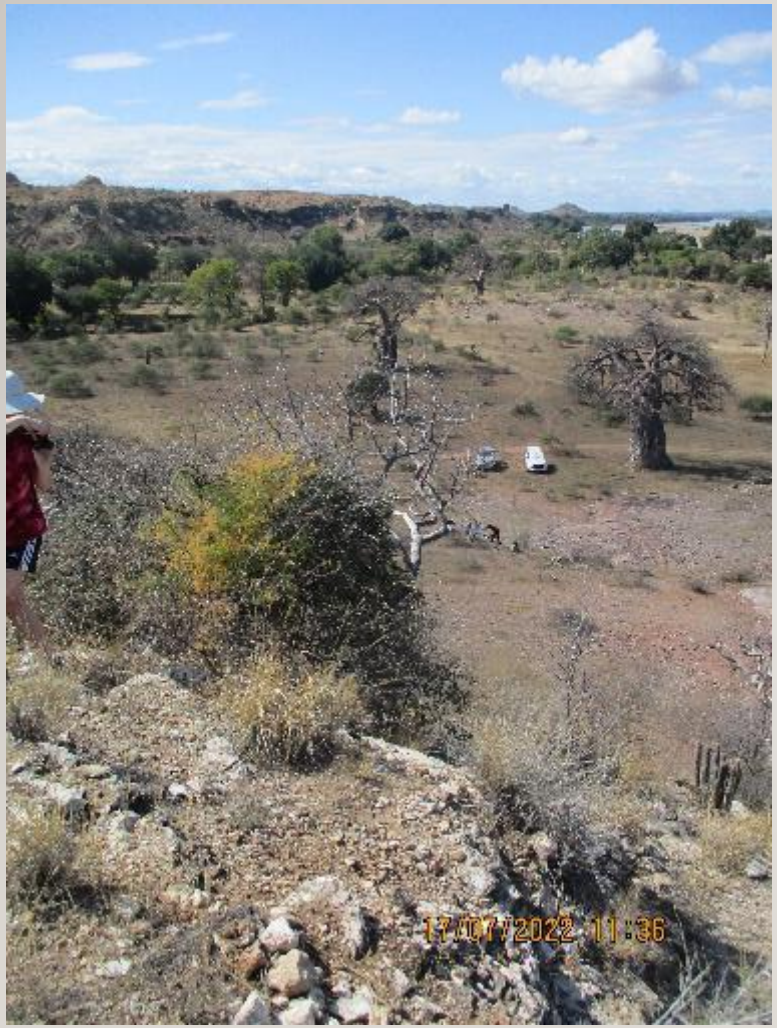


Fossil bone was first discovered and described on the banks of the Limpopo River by Ian Robertson during the 1964 Rhodesia School-boys Expedition to Sentinel. The Bristow family have since expanded on these discoveries in collaboration with the Natural History Museum in Bulawayo, an expedition led by Ray Rogers of Macalister University, Minnesota and now the Evolutionary Studies Institute at Wits in conjunction with the Natural History Museum, Kensington, London.

The latter initiative is in support of Michel Zondo (NHMZ) in his quest to obtain his MSc degree through further study of the Sentinel bone beds.

The Bristow's wish is that palaeon-tology will enhance the argument for a Trans-frontier Park linking Zimbabwe, Botswana and South Africa.

Wedding Hill, Sentinel



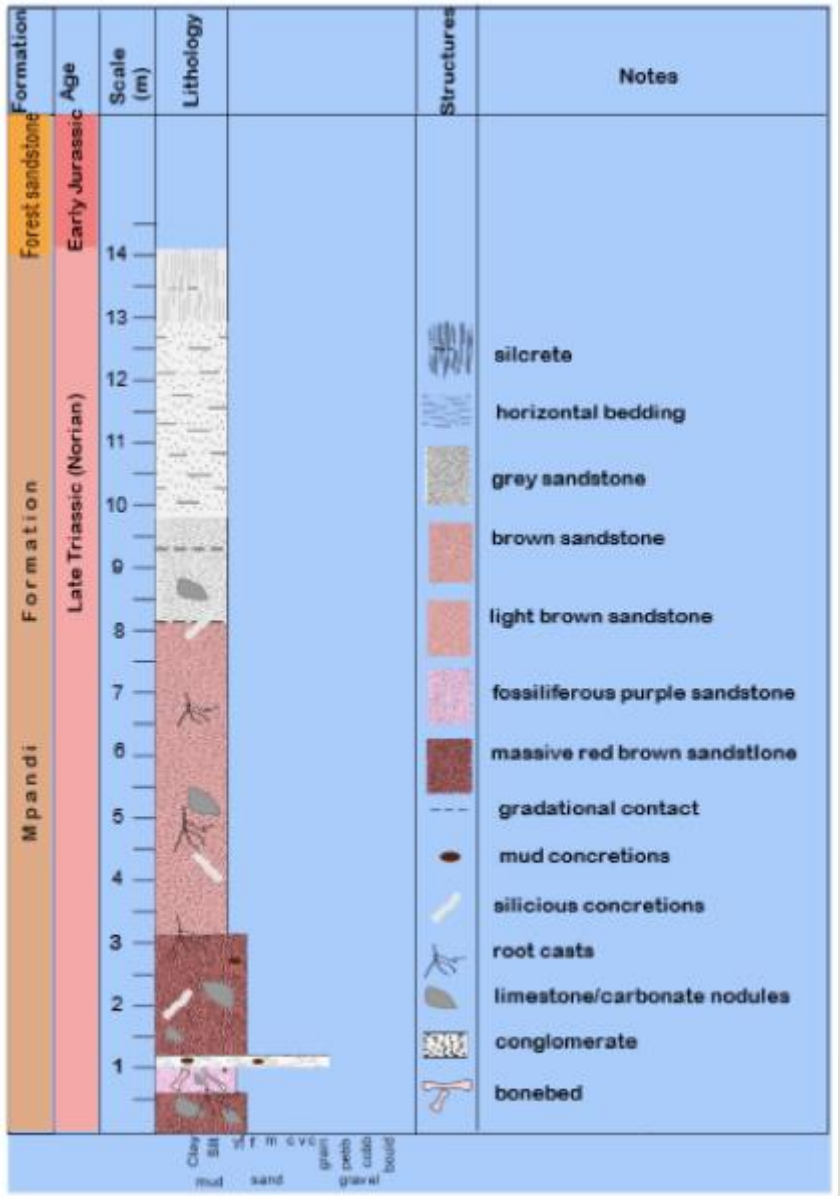
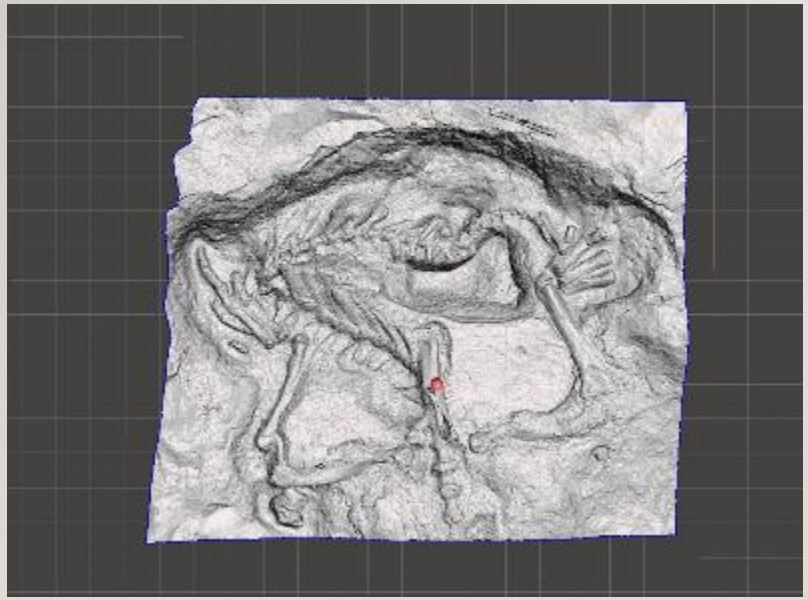


Figure 1.6. The stratigraphic section of the Wedding Hill done in 2021.

Paul Barrett

Atashni's articulated tibia & foot excavated & Jacketed, 2022.

Paul Barrett



‘Penny’ the *in situ* prepared hind quarters of ‘*Massospondylus*’
Sentinel Ranch

3D modelling by Matthew du Toit, 2021

Sentinel Enigmas and Challenges

Pimwe Hill – Tarquin Bristowe's recovery

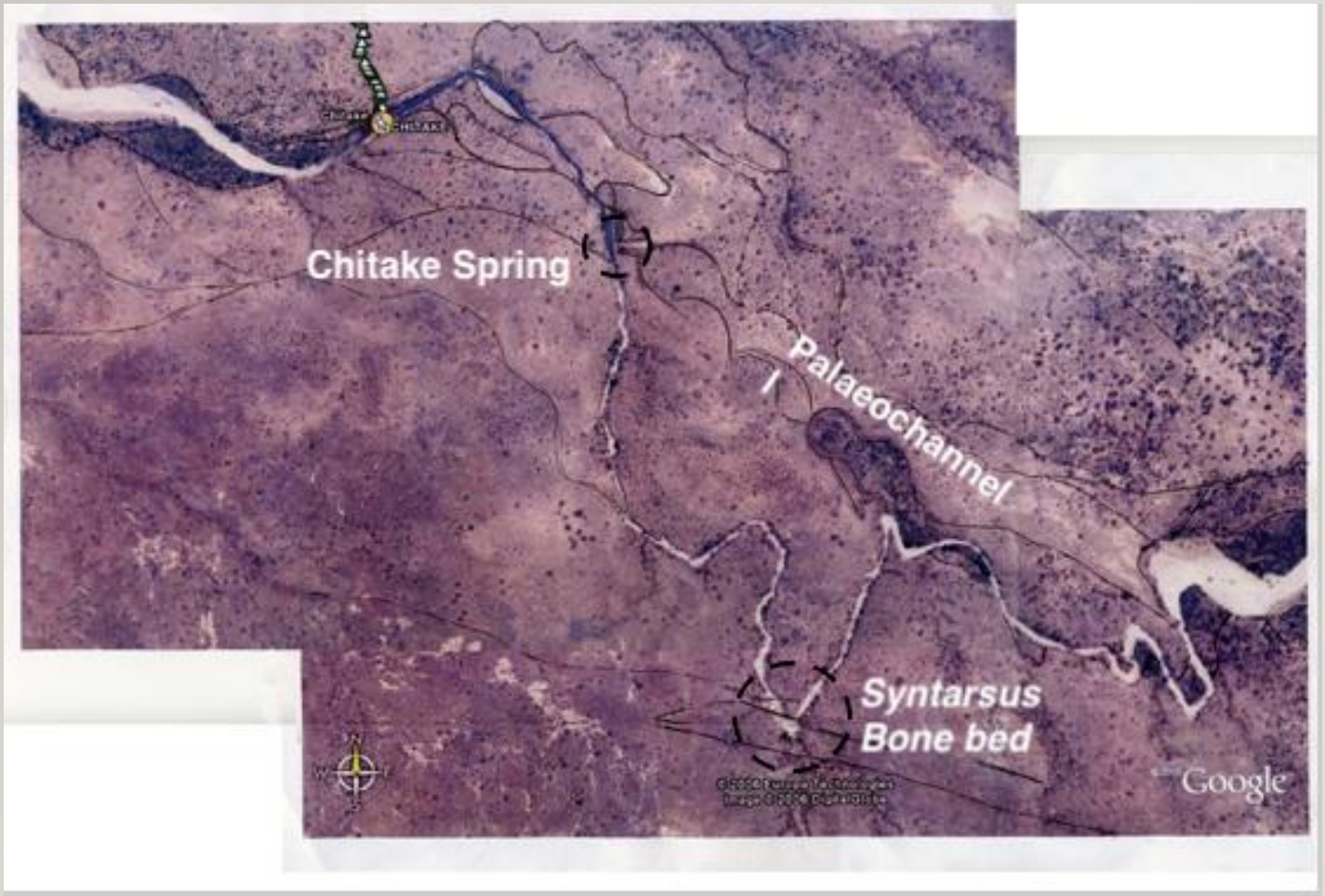
Wedding Hill silcrete surface. Dino footprints.

Serrated teeth – lizard-like

The 2022 Team

Atashni Moopen

Chitake, Mana Pools – Syntarsus Bone Bed



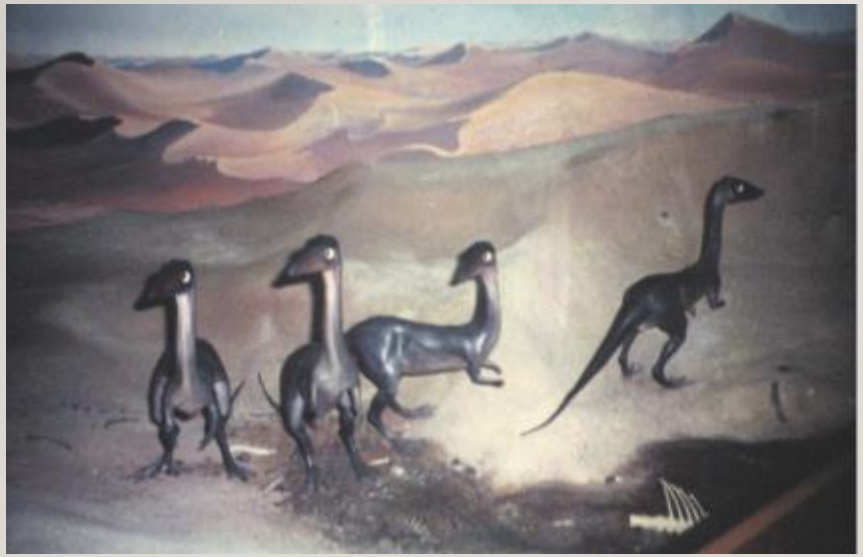
Upstream, river incised in Forest Sandstone

Raath to Orpen – 1985 – No bone

Mike Raath (QVM) discovered the Chitake bone bed in 1972 – this was his PhD thesis. Parts of some 40 individuals have now been excavated from this 5m-long 40cm-wide horizon, found to have exposed bone in 2007.

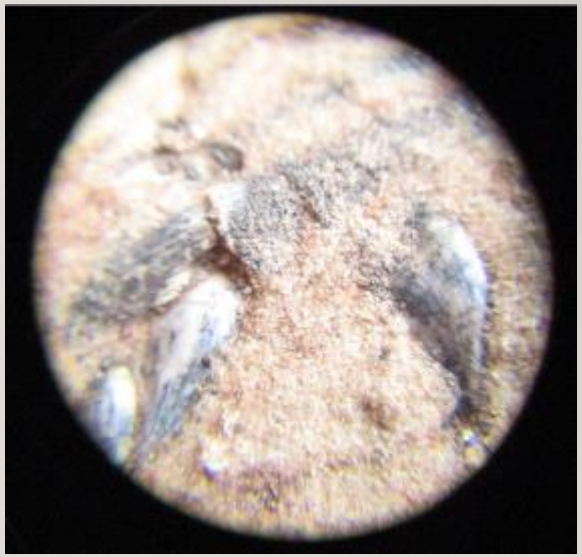
Again, in collaboration with National Museums and Monuments, three expeditions led by Eric Roberts, then of the Bernard Price Institute (ESI), Wits University and then of James Cook University, Queensland, were completed in 2007, 2009 & 2010. Supported by Patrick O'Connor and Nancy Stevens of the Ohio School of Medicine and, subsequently Matt Carrano of the Smithsonian, a number of jacketed blocks were recovered from the cliff-hung bone bed. Initially prepared at the BPI, the material was sent on loan to Ohio and the Smithsonian for detailed prep and cat-scanning.

Syntarsus – arid environment with local fluvial influence



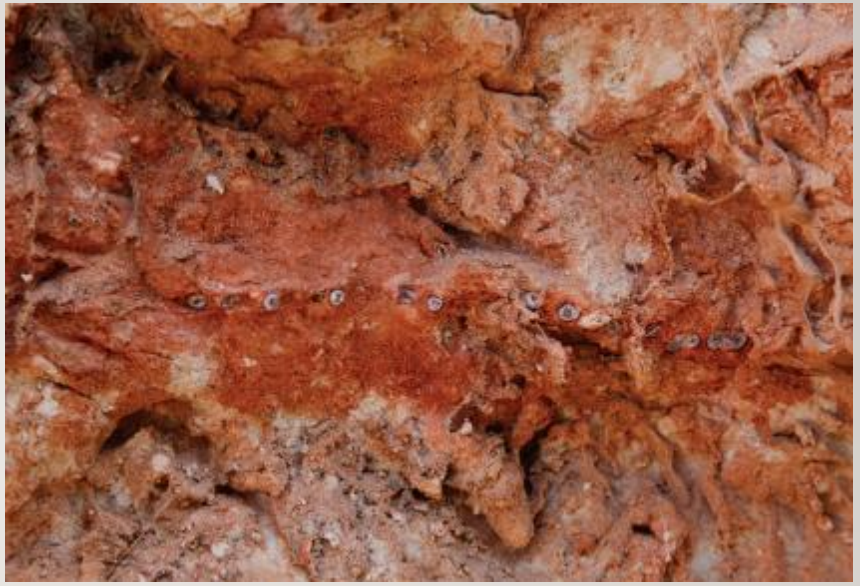
2007 – Distal caudal vertebrate and maxilla

Teeth in detail – Sue Worsely



2009 - Bone bed exposure

Lucy Broderick



2009 – upstream. A row of ribs indicate a new excavation for 2010

A slot prepared, blocks are jacketed and removed.

2009 Team. Blocks down and ready for transport.

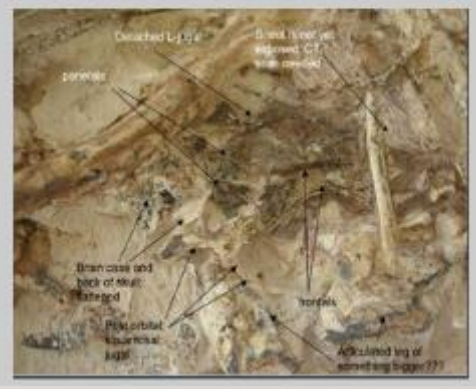
A Caudal Column Unfolds

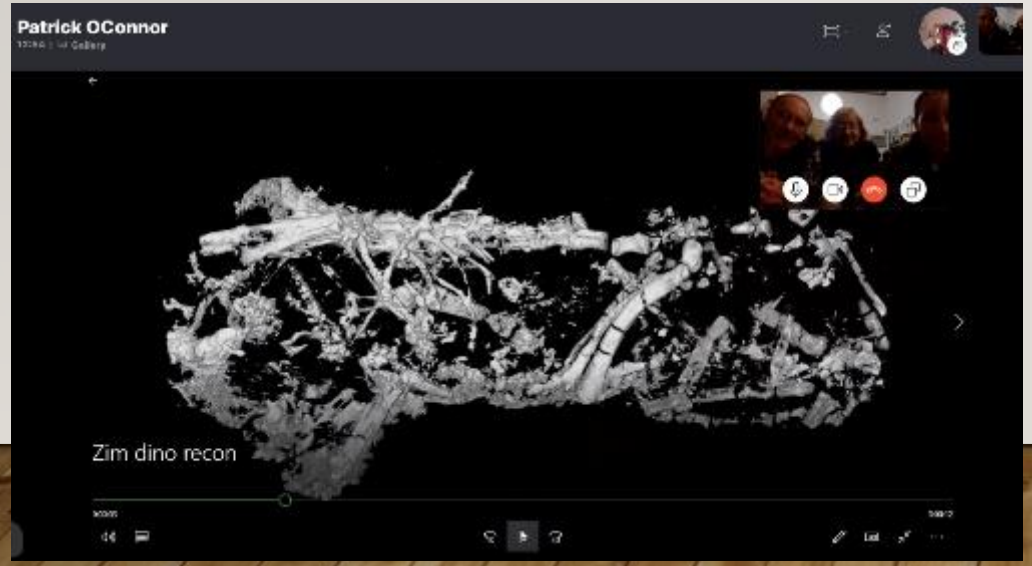
- Preparation of the large block at the Bernard Price Institute for Palaeontological Research at Wits, RSA, 2008

Eric Roberts

The Neck Bone Joins to the Skull Bone

- Detailed preparation reveals a neck and skull material. The specimen has now been shipped to the USA for a CT scan and more detailed preparation.





A cat-scan revealing bone in one of the jacketed blocks from Chitake.
Patrick O'Connor

Cat-scan of the upstream prosaurapod block recovered in 2010

Patrick O'Connor

Other bone material has been found within the Forest Sandstone of the Chitake Gorge upstream of the spring such as near the old road crossing, mostly from isolate exposures, with indications of biodiversity. Larger bones indicate the presence presence of *Massospondylus-type* sauropodomorphs and lizard-like *Sphenodon* remains have been found in the syntarsus bone-bed., *Tuatara* in New Zealand being the only living relative. With each flood, notably 2022, erosion exposes new bone, which has been reported by Mark Edwards and Andy Smith.

Tuatara *(Sphenodon)*

Lucy Broderick

Syntarsus rhodesiensis was named by Mick Raath from Nyamandhlovu. However, it was found that a bug bears the same name and our little dino was arbitrarily renamed *Megapnosaurus*, much to Mick's ire. The import of the Chitake studies is that '*Syntarsus*' is a coelophysid theropod dinosaur, which can be compared to a similar mass death at Ghost Ranch where *Coelophysis* is the state dinosaur of New Mexico. Although it takes time, watch this space for further development, but when finding new material, add it to the story by reporting rather than allowing arbitrary collection for the ego.

Mana Angwa, Chewore SA

Raath, Smith and Bond 1970. A new Upper Karroo dinosaur fossil locality on the lower Angwa River, Sipolilo District, Rhodesia. *Arnoldia (Rhod.)*, Vol. 4 (35), pp. 1-10.

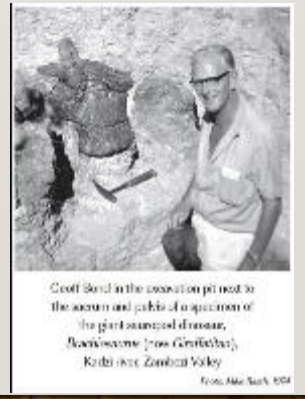
Lara Sciscio

The Maura crocodilomorph. Under the European Synchrotron as we speak.

Kathleen Dollman

Trish Broderick

Smith, V.A. 1970. The collection and preparation of a sauropod femur from the Gokwe Formation, Rhodesia. *Detritus*, Vol. 5, pp. 15-16.

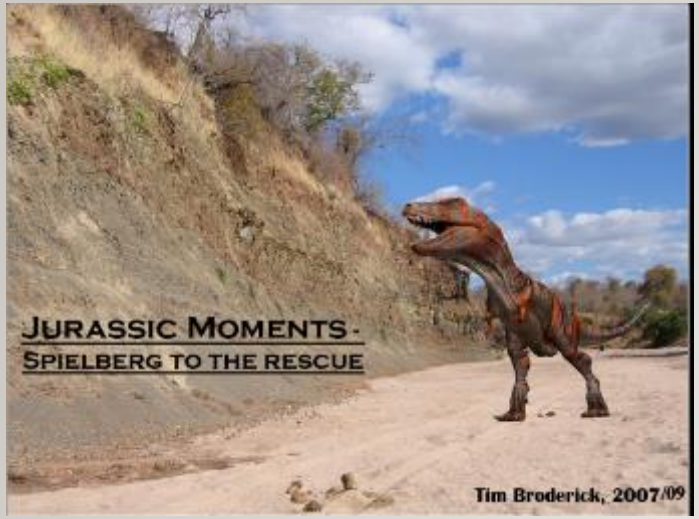


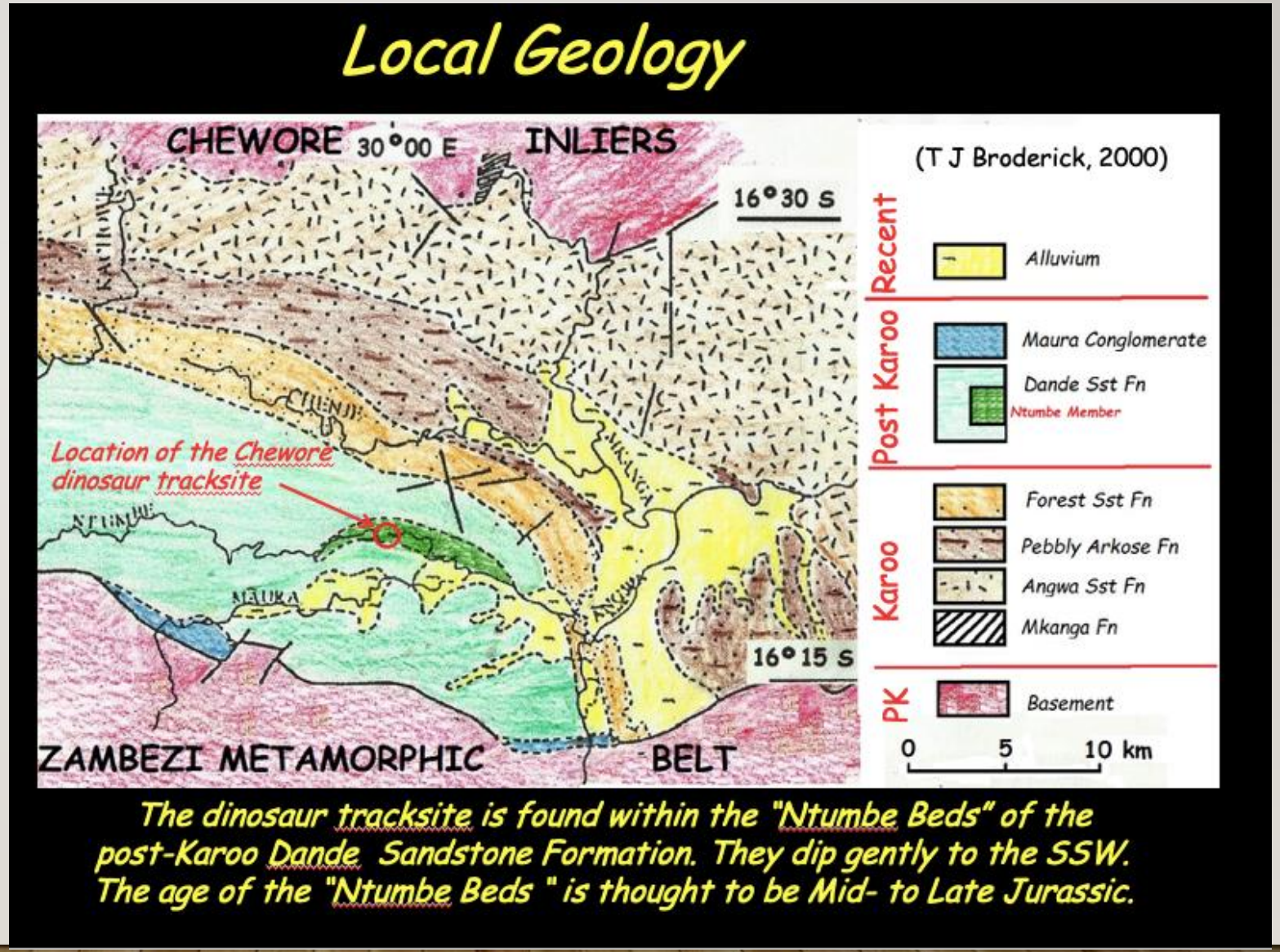
Geoff Boyd in the excavation pit next to the sacrum and pelvis of a specimen of the giant sauropod dinosaur, Brontosaurus [now Giraffatitan], Kadzi near Zambezi Valley

Gokwe Beds and the Kadzi area, Muzarabani

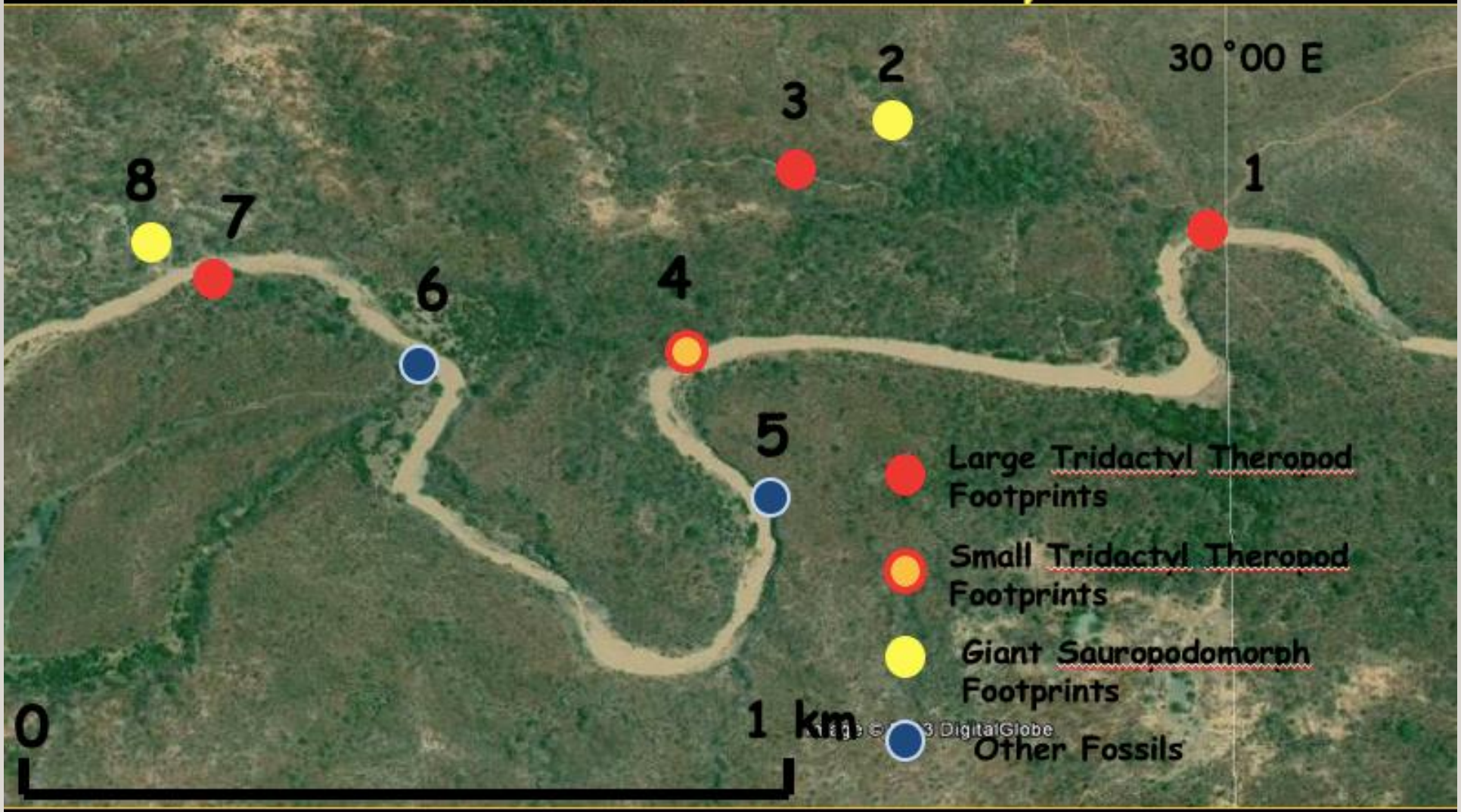
Raath and McIntosh 1987. Sauropod dinosaurs from the Central Zambezi Valley, Zimbabwe, and the age of the Kadzi Formation. *S. Afr. J. Geol.*, Vol 90 (2), pp. 107-11

The Ntumbe Dinosaur Tracksite, Chewore Safari Area





The 6 main Ntumbe River Footprint Sites

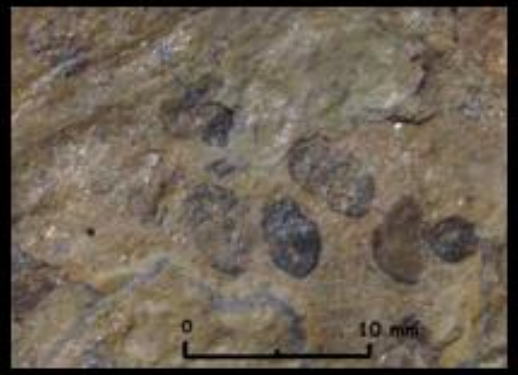


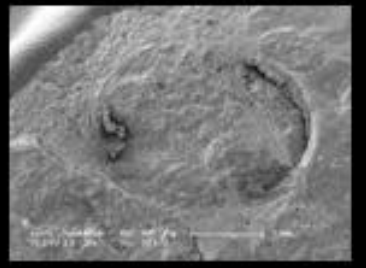
All main sites are located in an area of 1,5 x 0.5 kms. Some other sites with less than 4 prints are not shown here.

The "Ntumbe Beds"

The "Ntumbe Beds" are interpreted as a distal alluvial fan facies, reflecting the presence of seasonal meandering rivers and over bank wetlands. They comprise cross-laminated fine- to medium-grained sandstones preserving ripple-marks and desiccation cracks intercalated with green mudstone layers that contain freshwater conchostracans, and a flood sequence entombing the bones and scales of Lepidote fish.

Sandstone and mudstone interbeds showing rippled surfaces and sandy infill to desiccation cracks. Matt Carrano (Smithsonian) and Eric Roberts (James Cook University) in attendance.





Electron Microscope detail

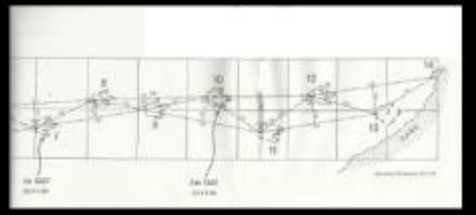
Freshwater conchostracans

Lepidote fish scales

Fish bones

Tridactyl theropod footprints: Site 1

- The first bipedal theropod track was found in 1984 and surveyed by T.J. Broderick (in picture) in November. He described a 15 m-long succession of 14 footprints across a south-dipping sandstone pavement.



Found by hunter, Mike Aldesey with John Tolmay in August 1984. Reported to Adelaide Museum, S.A., reverting through John Orpen to Tim and Patricia Broderick who, with Lovemore Mungwashu (NP, late of the QVM), first recorded the Ntumbe footprints in November 1984.

Site 1

The average width of the trackway is 0.47 metres.

The pace varies from 1.1 to 1.32 metres.

The stride is 2.11 to 2.45 metres

Prints on average are 40cm long from heel to toe, 33cm wide from toe to toe and 2cm deep.

They clearly show 3 forward protruding toes, which were clawed.

Many prints show evidence of either heel drag or slip, which averages 0.21 metres in length.

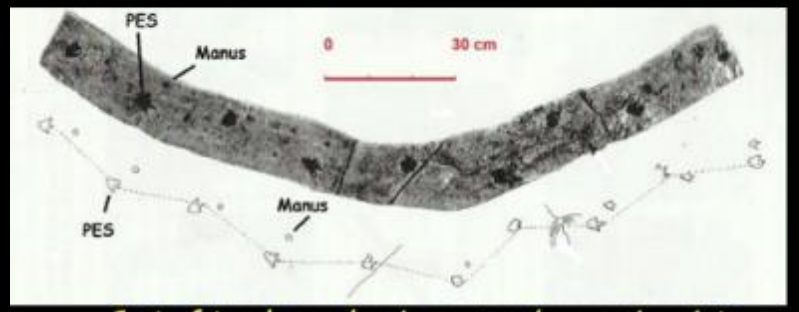
(T J Broderick, 1985. Technical Report, Geological Survey of Zimbabwe)

Site 1 – Operation Raleigh, 1990

- The site was excavated and 31 new prints were recorded from beneath the left alluvial bank and riverbed sand. The trackway was then visible over a length of 48m. Casts of rubber latex with glass fibre backing were made for the Zimbabwe Natural History Museum in Bulawayo.

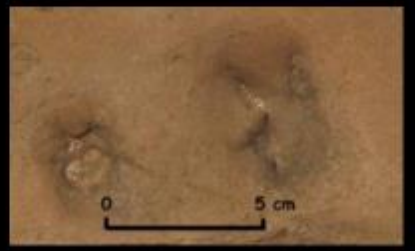
Lingham-Soliar, T. and Broderick, T. 2000. An enigmatic Early Mesozoic dinosaur trackway from Zimbabwe. *Ichnos*, Vol. 7 (2), pp. 135-148.

Very small tridactyl theropod footprints : Site 4



Cast of trackway showing pes and manus imprints

Site 4 is preserved on a single block of sandstone. A number of small tridactyl theropod footprints, less than 5cm in length, may reflect a nursery site (Lingham-Soliar and Broderick, 2000).



Sauropodomorph dinosaur footprints : Site 2

Print 1 of Site 2

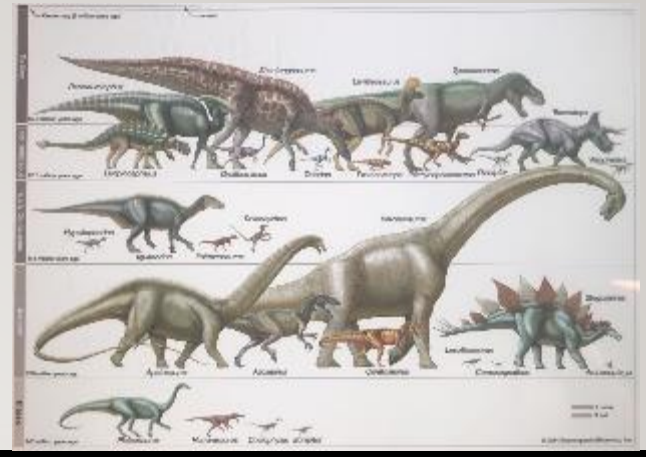
In 2001, during his survey, A. Ait-Kaci discovered (on site 2) the first sauropodomorph dinosaur footprints in sub-Saharan Africa. A fairly well preserved footprint was 94cm in length including a 30 cm-long heel-drag. The maximum width was 56cm across and the depth was 20cm at the front. This showed the impression of 3 or 4 short toes, each less than 10cm in length. A raised ridge of fine-grained sandstone, 20 to 35 cm-wide and 5 to 15cm above the pavement surrounded the print. The ridge bulged forwards.

Ait-Kaci Ahmed, A., Lingham-Soliar, T. and Broderick, T. 2004. Giant sauropod tracks from the Middle-Late Jurassic of Zimbabwe in close association with theropod tracks. *Lethaia,* Vol. 37, pp. 1-4.

Cretaceous

Jurassic

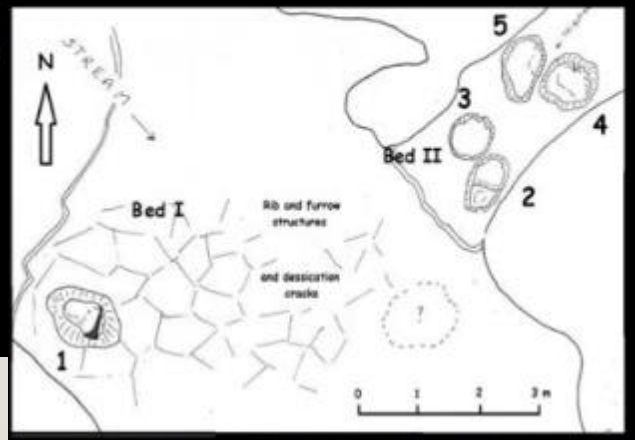
Triassic



Dino Biodiversity

Zimbabwe assemblage

SITE 2



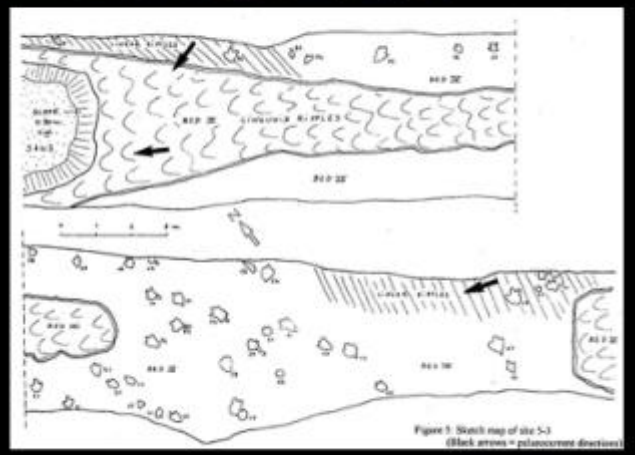
A few metres away to the NE, four other prints (2, 3, 4 and 5) are impressed on a slightly higher bed.

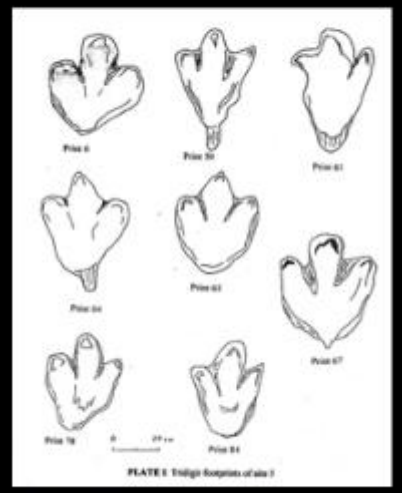
Print 3 of site 2

In 2003, Print 1 was unfortunately destroyed by elephants as the location is the site of a spring.

Site 3

The site was surveyed in 2001 by Dr. A. Ait-Kaci (left). Several trackways can be discerned with a general northerly travel direction (on the right, T J Broderick)





(Dr A. Ait-Kaci, 2002. Technical Report, Geological Survey of Zimbabwe)

Lingham-Soliar, T., Broderick, T. and Ait-Kaci Ahmed, A. 2003. Closely associated theropod trackways from the Jurassic of Zimbabwe. *Naturwissenschaften*, Vol. 90, pp. 572-576.

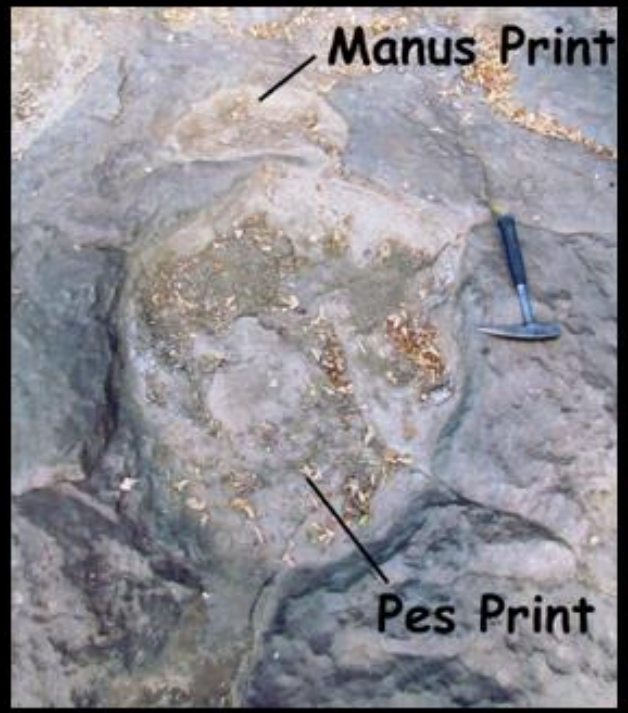
Then upstream another pavement with a trackway of 14 prints, crossed by a roaming sauropod.

Tridactyl theropod footprints : Site 7

Site 7 is located upstream on the right bank of the Ntumbe River and is very similar to Site 1. A thick sandstone pavement bears a dozen tridactyl theropod footprints forming a straight trackway, about 15 m-long. Near its termination, a rounded print (top right picture) could have been made by a Sauropodomorph dinosaur.

Sauropodomorph dinosaur footprints : Site 8

New sauropodomorph dinosaur footprints were found at site 8 by Mrs P. Broderick in 2007.
Site 8 comprises more than 6 large rounded Sauropodomorph pes prints, 80 to 95cm across with corresponding crescent-shaped manus impressions being clearly visible.



New finds, August 2021

Sauropod – toe imprints LMB

Something new – A Stegosaur? LMB

Drama at the Spring




Palaeontology of the future - What's New?

Yaguta!

Photo Credits: Lucy Broderick, Trish Broderick, Tim Broderick, Di Hull, Ken & Sue Worsley, Ali Ait-Kaci Ahmed, Theagarten Lingham-Soliar, Chris Rance & Eric Roberts

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