

Regionally Connected Structural Systems: the Power of the Big (Continental-Scale) Picture*

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Abstract

Beyond offshore West Africa where modern densely sampled data from ships and satellites have played a key role in current understanding of passive margin evolution, Africa is in general rather unevenly known, especially in the subsurface in more remote areas. The GIS-based Exploration Fabric of Africa (EFA, the 'Purdy project') was designed to address that problem. It includes structural features such as faults and basin outlines but at a very high and often generalized level, divorced from their underlying genetic linkages. We have undertaken to compile a more detailed tectonic synthesis aimed to integrate understanding of the oceanic margins with the continental realm. This is an overlay to EFA with a variety of public domain, published, non-exclusive, and derivatives of proprietary work at a closer and more detailed level, importantly guided by known patterns of structural styles. Potential field (gravity and magnetic) data provide guidance in locating, extending, and connecting key mapped features; we then rely on the kinematic patterns to predict missing details in a testable interpretation. The result is a detailed structural features map that can function as a framework within which to target and prioritize both conventional and unconventional activity by operators and licensing/regulatory organizations. We illustrate the process in theory and in practice along the Central African Rift System (CARS), where data is sparse. This fault linkage systems approach has flagged underexplored areas where unmapped structure is likely that could, for example, be targeted with hi-resolution geophysical data. A similar system to CARS appears to cross southern Africa from Namibia to Tanzania - a "Southern Trans-African Rift system" or STARS. Exploration in the eastern Owambo Basin resulted in the mapping of a pull-apart basin from depth-to-basement inversion of high-resolution magnetic data and subsequently studied with structural modeling. Thinking in terms of such fault and structural systems, this 'Kavango Basin' can be related along strike to the Karoo Basins in Eastern Africa via features such as the Omaruru lineament, implying the possibility of a fairway of extensional basins and shears across the continent that are not obvious in existing low-resolution data. STARS represents a blue-sky frontier concept for both conventional and nonconventional exploration potentially offering new exploration leads, the ultimate objective of big picture work.

Regionally connected structural systems: the power of the big (continental-scale) picture

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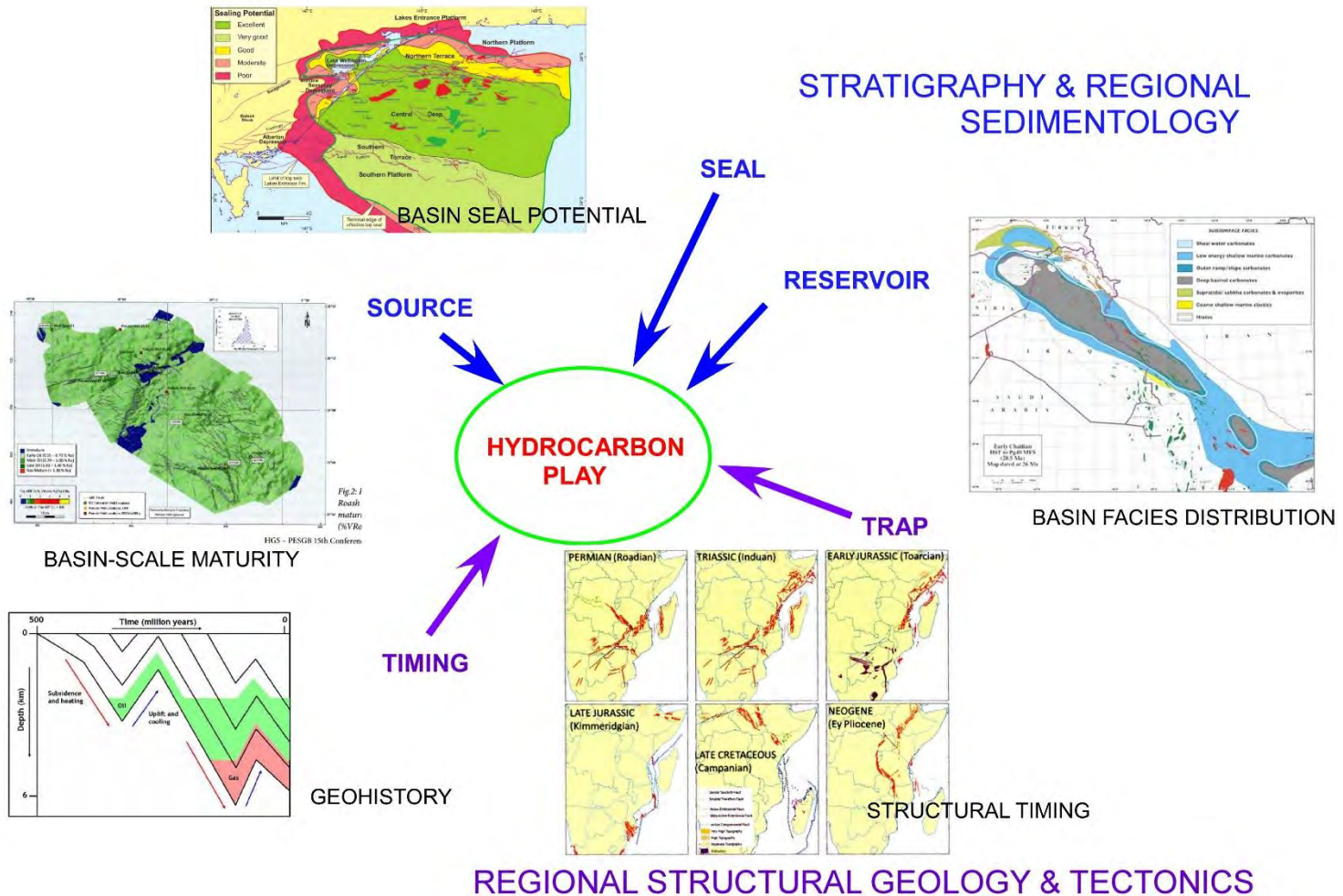
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- 1. *What* do we mean by the “Big Picture”?**
- 2. *Who* benefits from paying attention to the ‘Big Picture’?**
- 3. *How* and when does it relate to the upstream work flow?**
- 4. *When* to use it?**
- 5. Some African examples, from the tectonics disciplines**



Who can benefit?

- Operators
- Ministries

When to use it?

Influences decision making processes,
provides a framework >>

Any time in the exploration, leasing cycles

How to do it?

“Old days”: paper and ‘corporate’ memory

Modern: GIS (or at least digital) with the following advantages

Transcends scales

Easily edited

Enhanced data management: attribute tables right in project

Integrate! Integrate! Integrate!

BASIS OF THE UNDERLYING PROJECT

PURPOSE

To create a continent-wide compilation of African structural elements that is kinematically sound

- Rationale that there has not been a continent-wide tectonically focused data set
- Progress in surrounding ocean basins and on continental margins has not been paralleled onshore

MEDIUM AND COMPONENTS

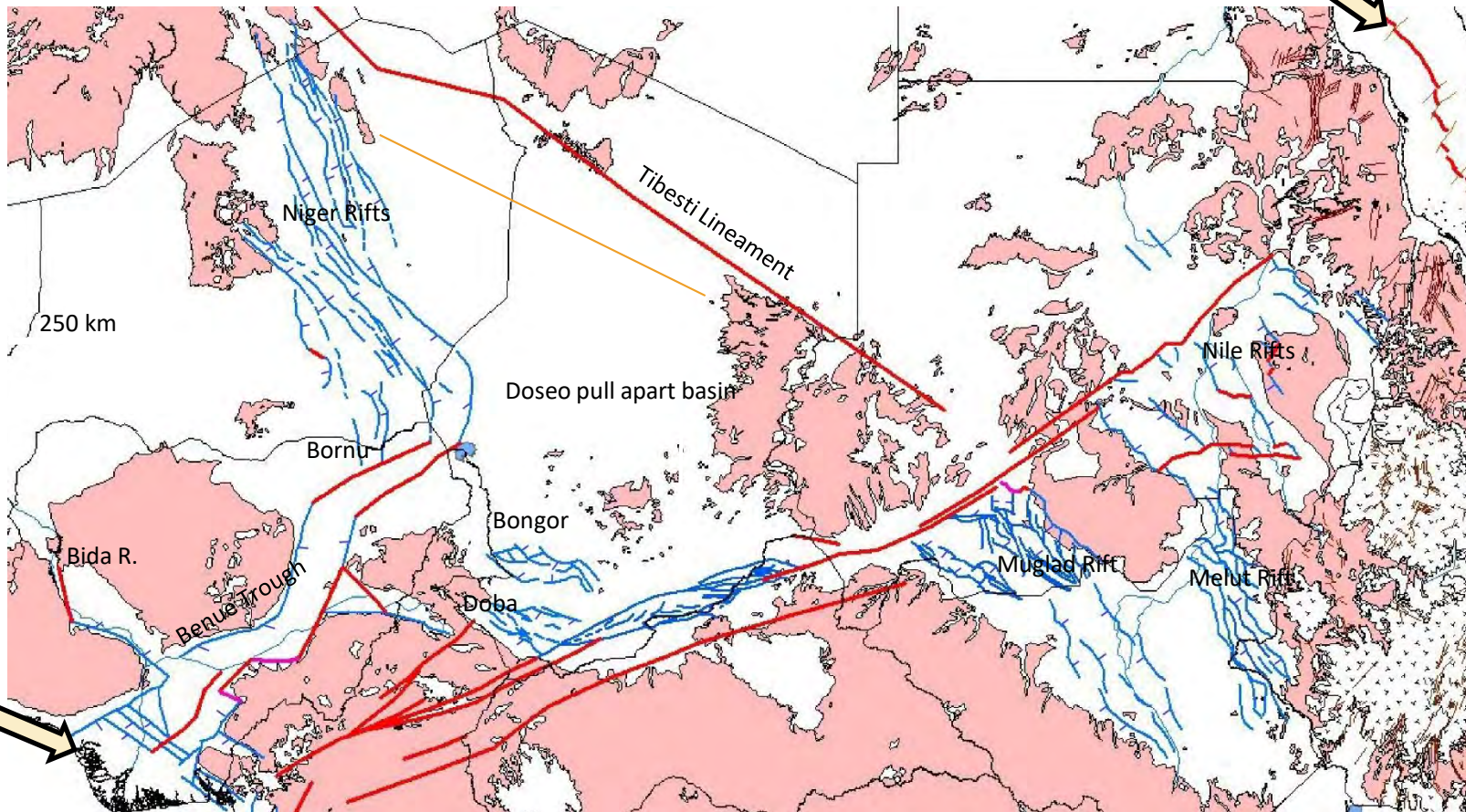
Purdy Exploration Fabric of Africa (EFAfrica.com), foundation material that is GIS-based Literature plus proprietary material available to the authors

Original work

Continental-scale compilations of potential field data and its inversions

Elements of CARS/WARS & CASZ

Red Sea (Cenozoic)



Niger Delta
(Cenozoic)

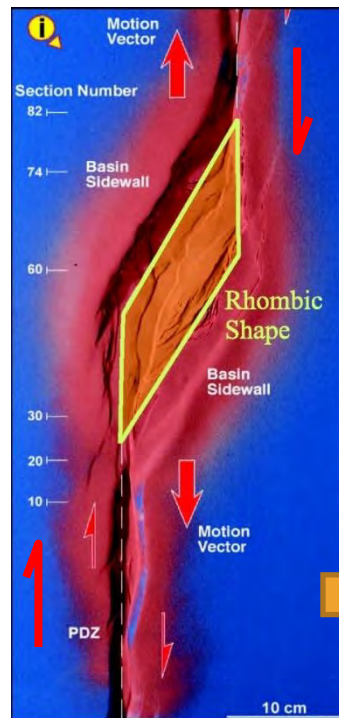
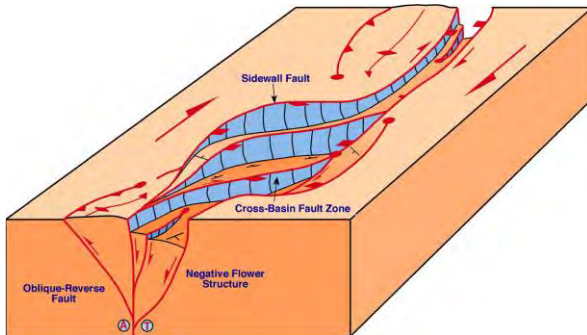
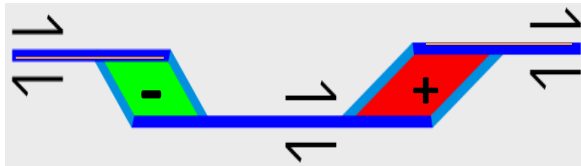
basement outcrop in pink

ArcGIS shapefiles

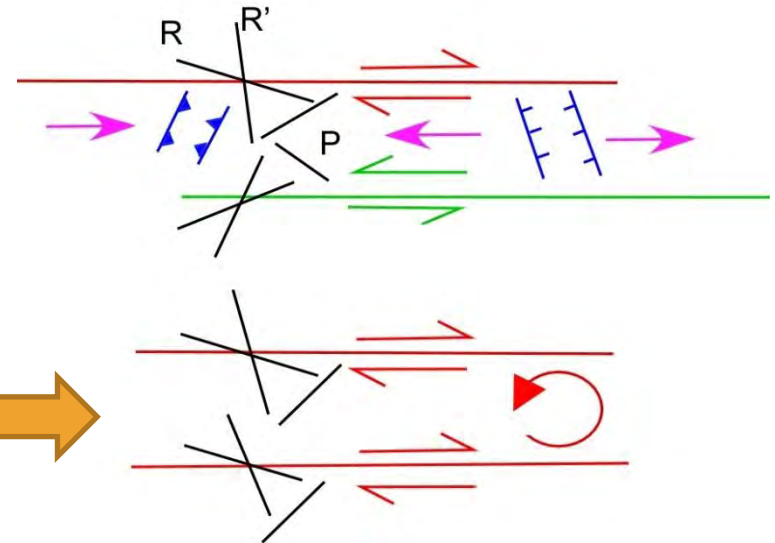
Bending, Side-stepping, & Overlapping-Paralleling Wrench Segments

Or, how the wrench segments interact along strike.

**Bending and Side-stepping:
Classic rhombic pull-aparts
and uplifts**

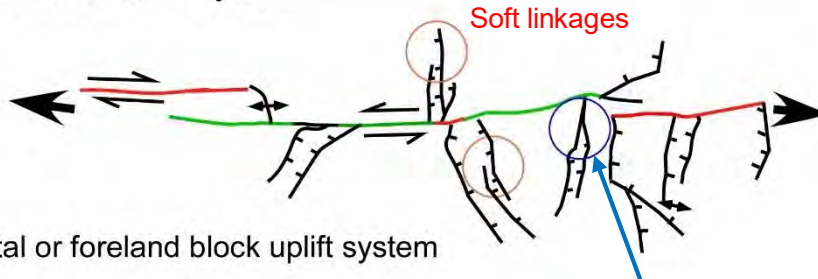


**Paralleling wrenches unpredictable:
Largely dependent on cumulative slip
and relative propagation direction**



“Mega-shear” linkage systems

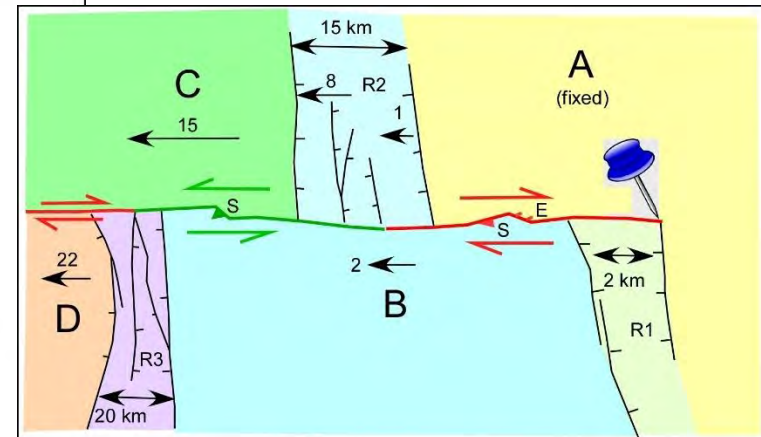
a. intra- or trans-continental rift system



b. intra-continental or foreland block uplift system

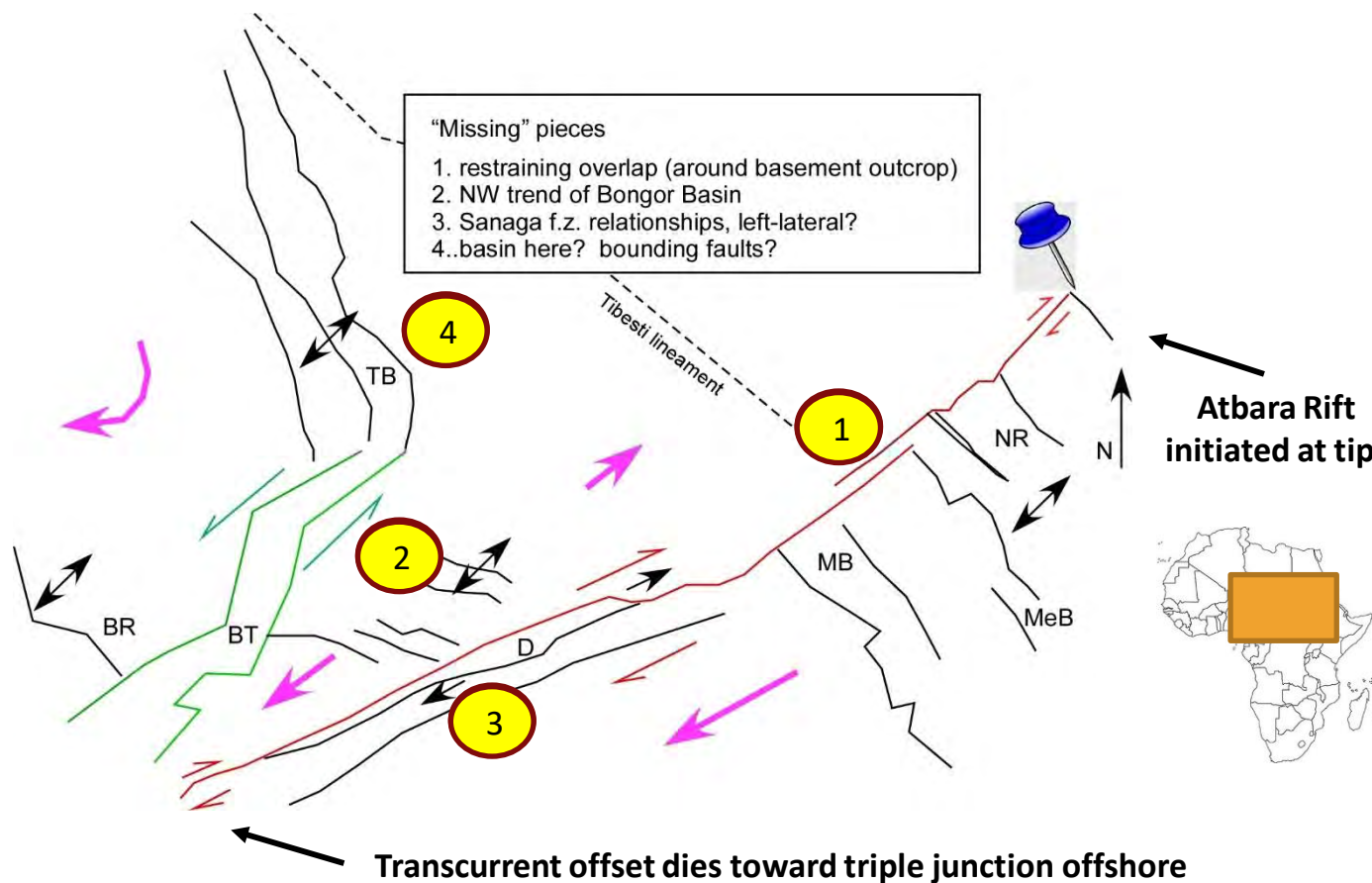
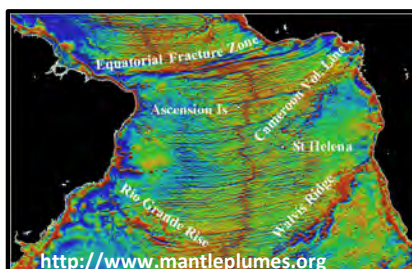
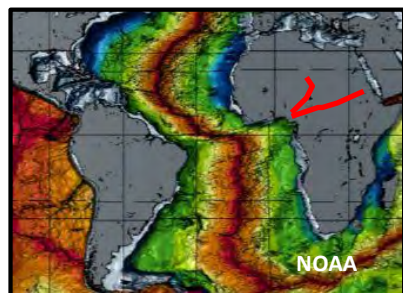


c. releasing and restraining bends on a true strike-slip or transform system



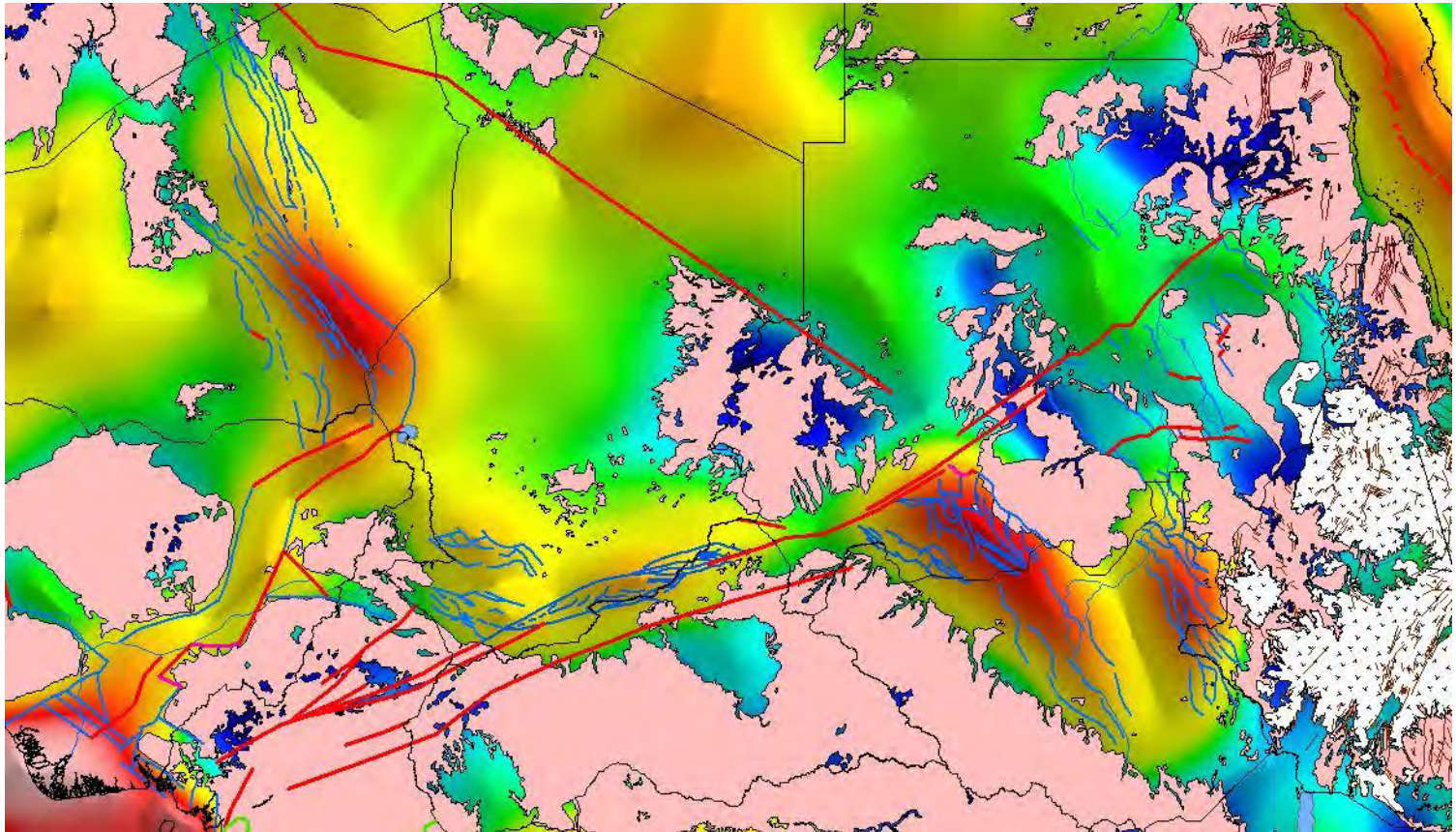
Hypothetical illustration of
reversal in sense of offset

CARS/CASZ schematic synthesis

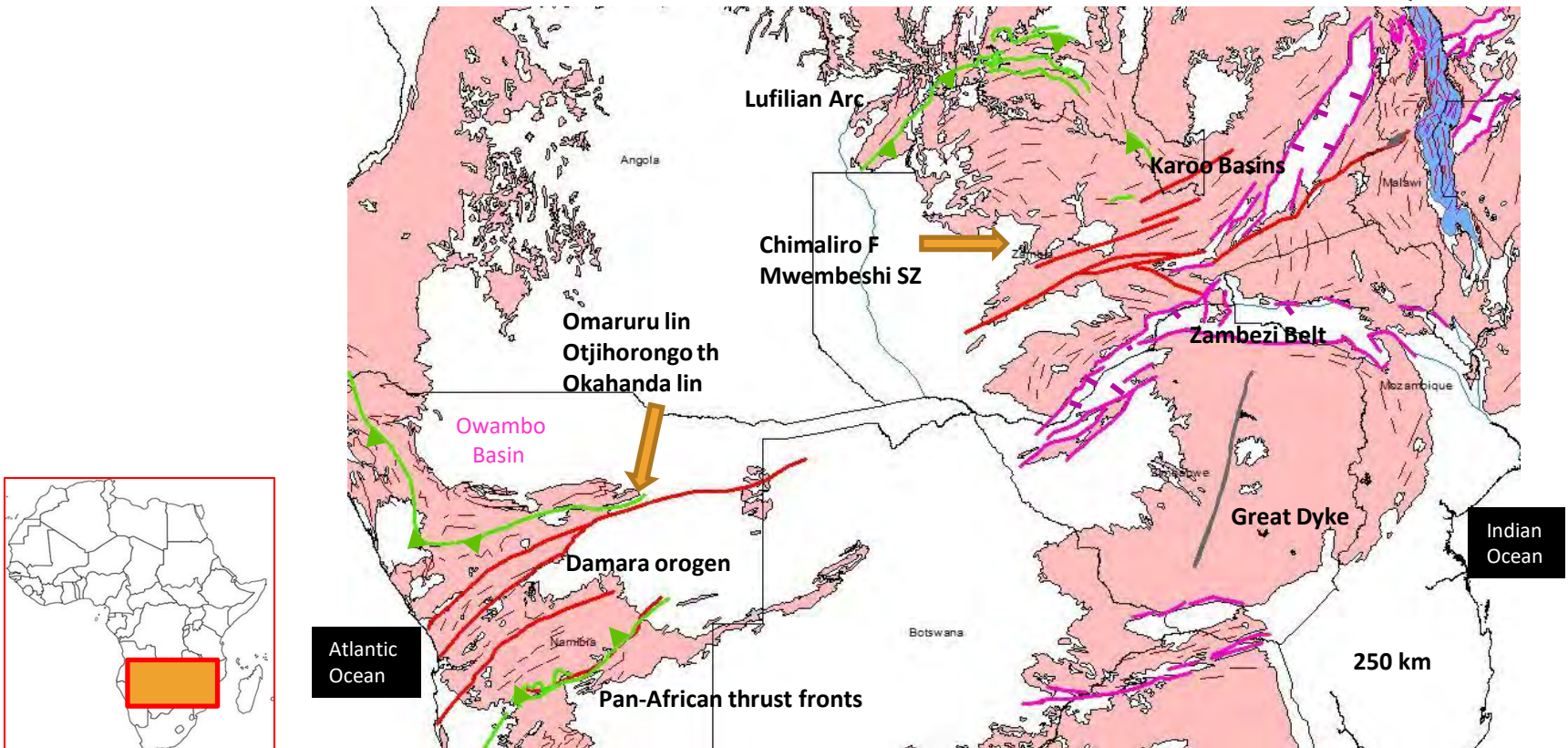


CARS/CASZ with gross sediment thickness inversion: basin locations

MARIMBA
sediment
thickness
inversion



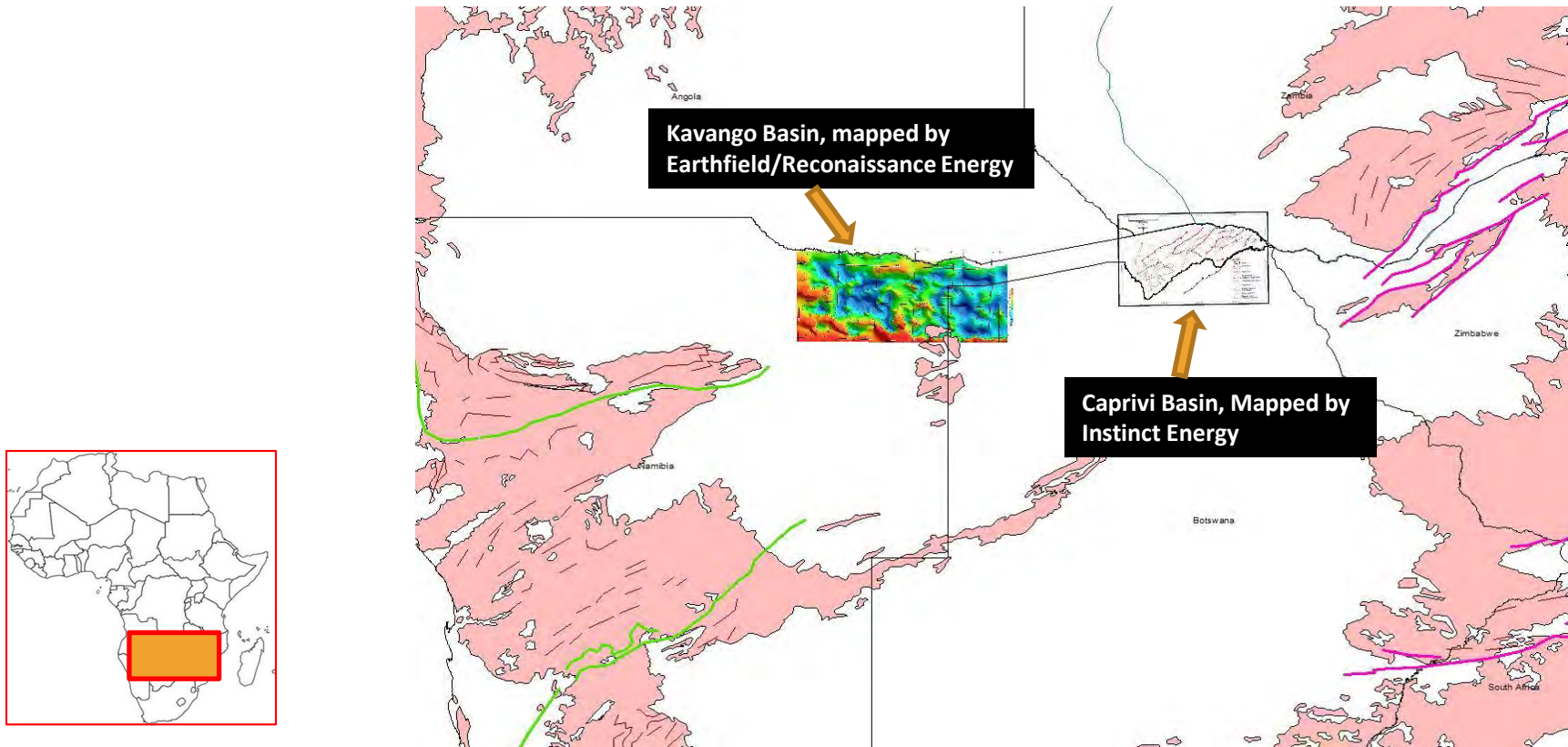
“Southern Trans-African Rift System” (STARS) exposed elements

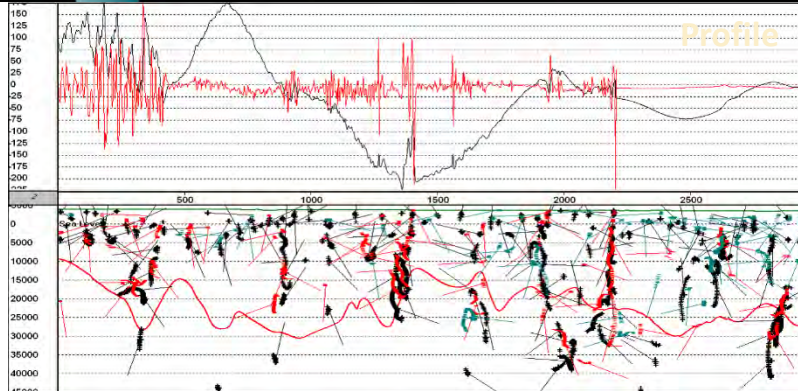


basement outcrop in pink

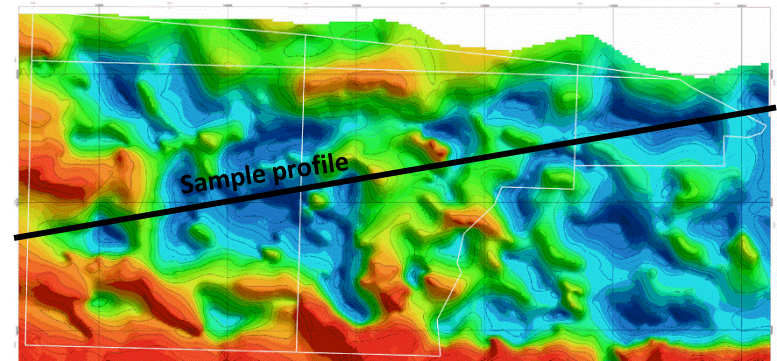
ArcGIS shapefiles

NEW ELEMENTS of the “Southern Trans-African Rift System” (STARS)

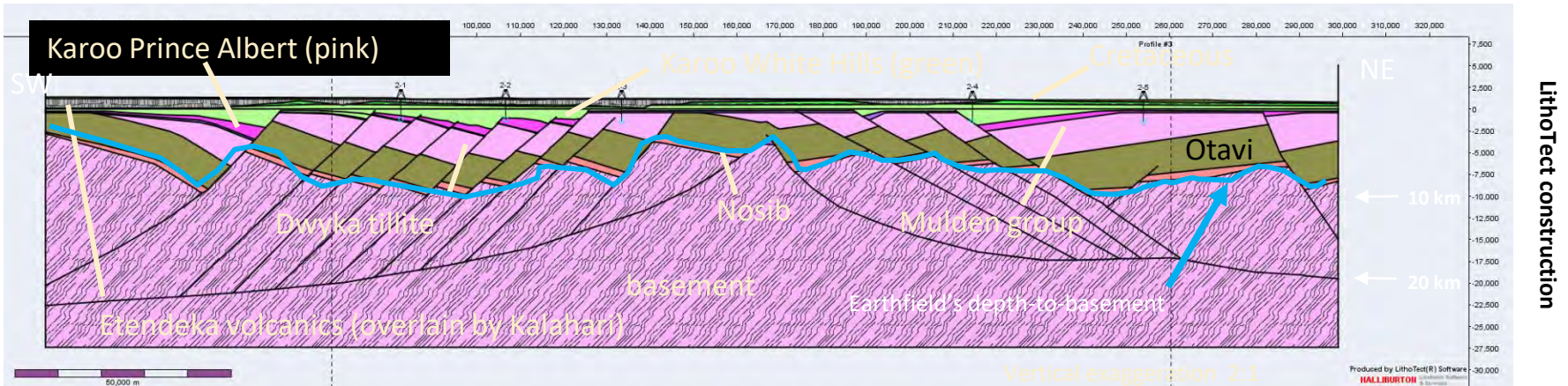
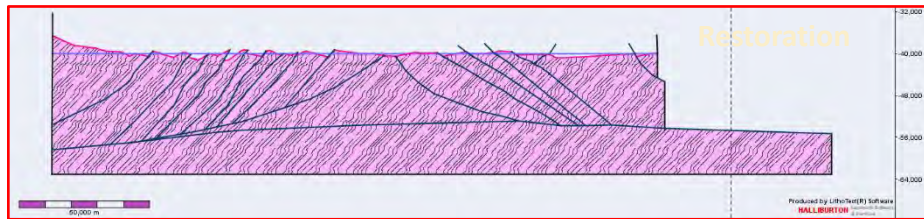




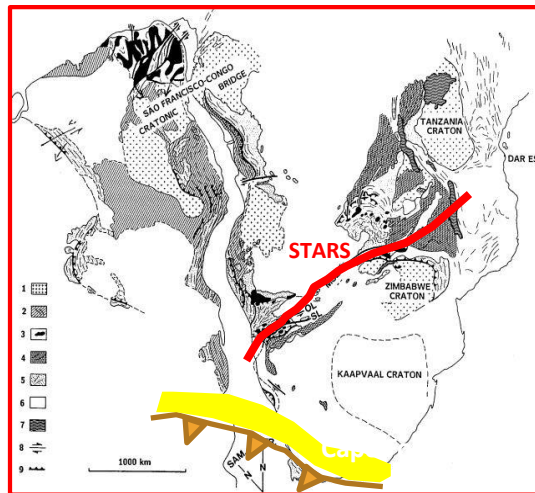
Structural modeling in Kavango Basin Depth to basement Werner inversion



Bill Cathey, Earthfield Technology

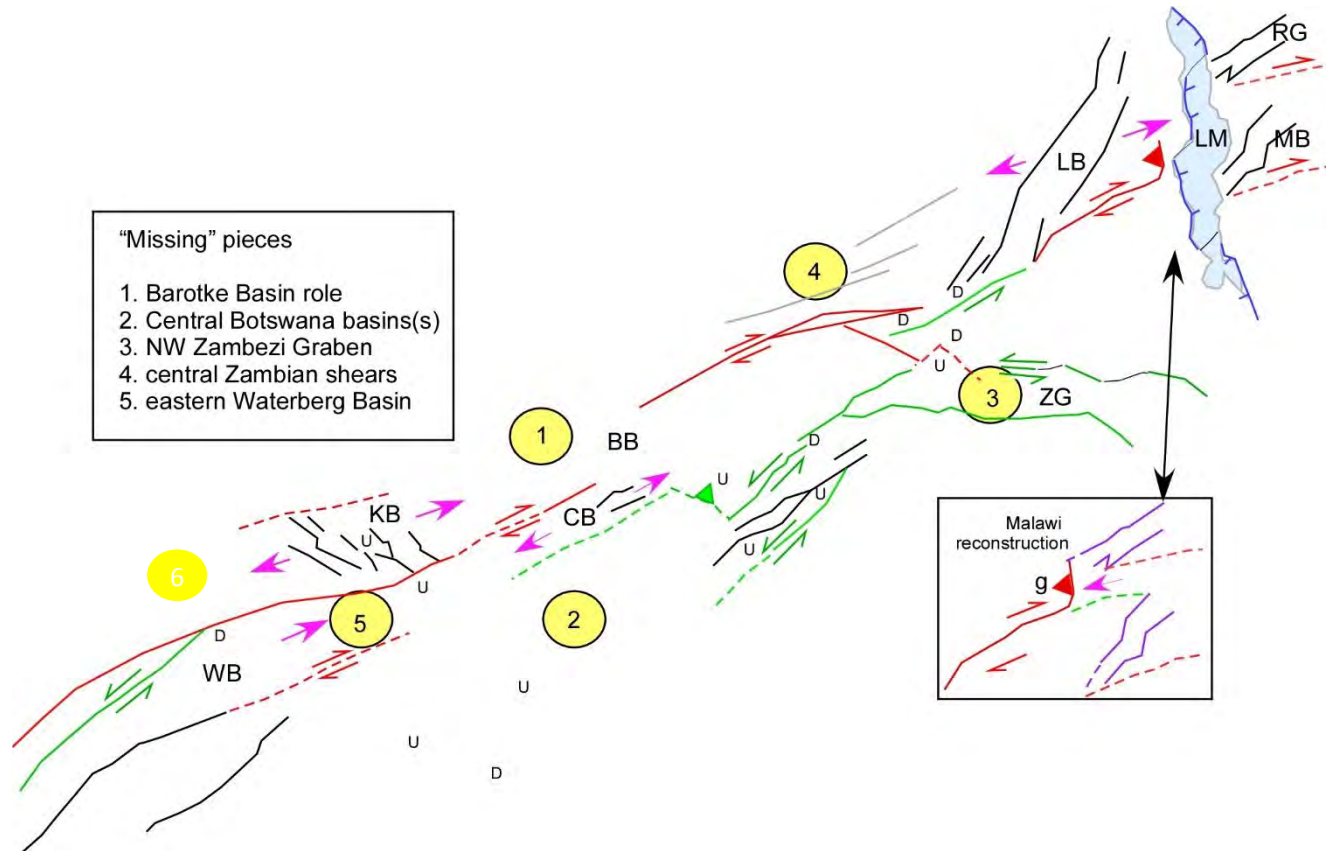


STARS schematic synthesis



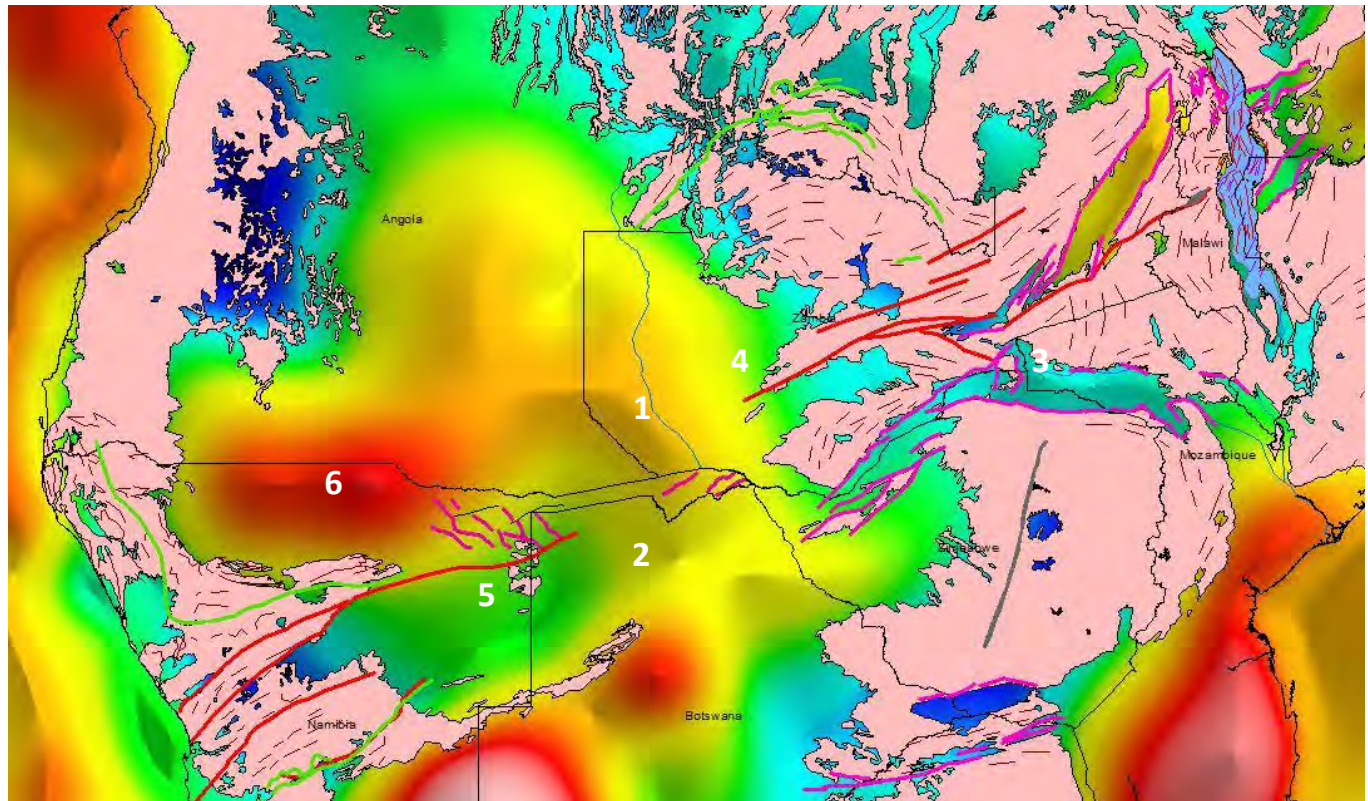
"Missing" pieces

1. Barotse Basin role
2. Central Botswana basin(s)
3. NW Zambezi Graben
4. central Zambian shears
5. eastern Waterberg Basin



STARS with gross sediment thickness inversion: missing basin locations

MARIMBA
sediment
thickness
inversion



CONCLUSIONS

- “Big Picture” is an integrative way of thinking, useful in exploration from both the operator and the ministry point of view
- “Big Picture” capable of giving leads to missing tectonic elements
- Intraplate deformation is commonly organized as structural styles or blended structural styles
- The systems can be understood in terms of known structural styles and interplay of the elements of those systems
- Two examples are the well known Central African systems and a less recognized trans-southern Africa system (STARS), recognized as the Karoo system in eastern Africa
- This application of ‘systems structural geology’ can be used to predict missing structural elements or to guide new ventures exploration

