Defining Frontier Petroleum Systems with Higher Granularity: Examples from Plate Reconstructions of the Atlantic Margins

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Summary and Introduction

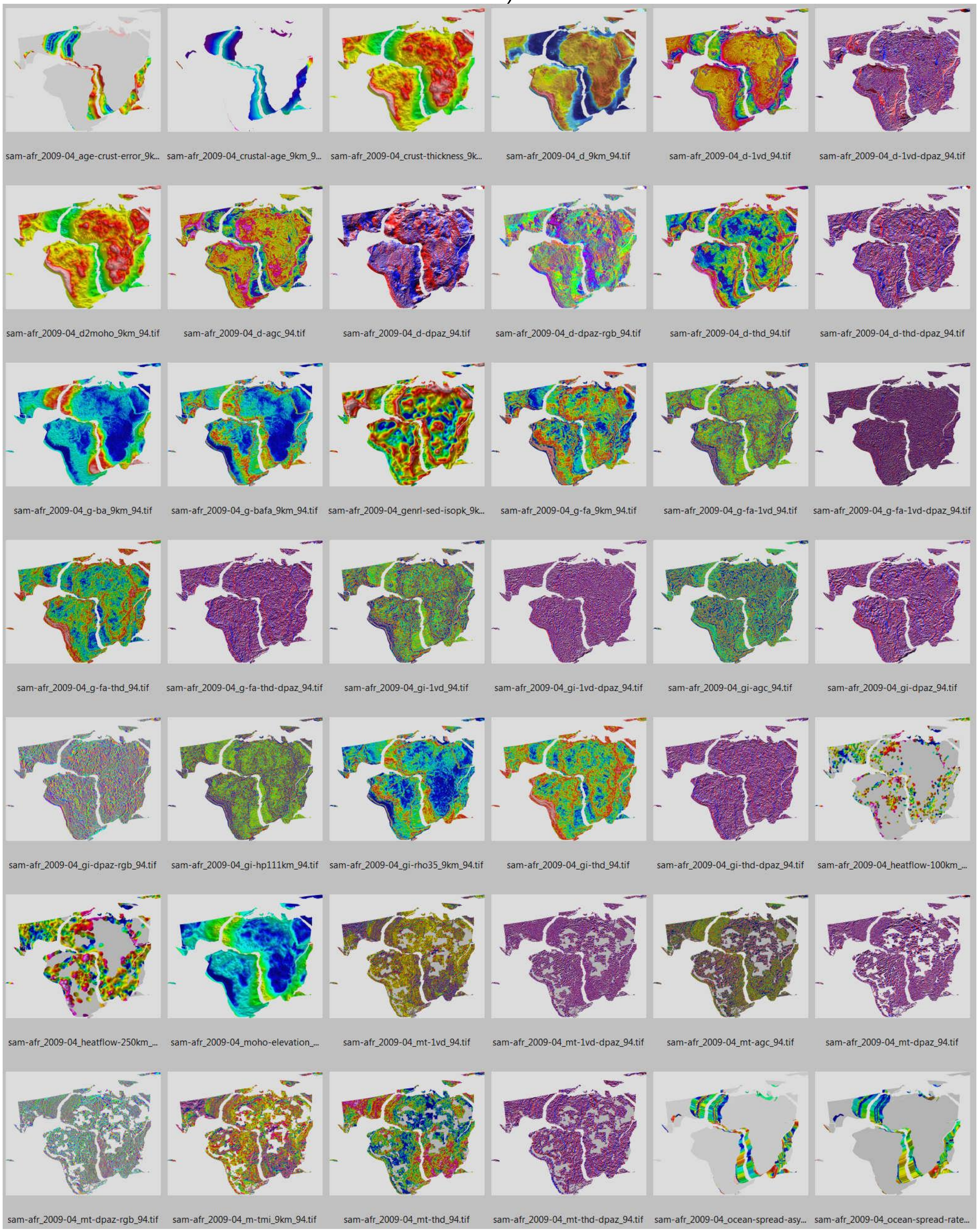
Plate reconstruction software and plate models are evolving towards true restoration of pre-rift configurations rather than simple rotations-plus-translations of present-day maps. However, most models are defined from vector data (points, lines or polygons) that under-represent the resolution within newer global geophysical data coverages. These models are used to simulate paleo-environments that produced hydrocarbon source rocks but again, there is a general paucity of hard geochemical data to test models of source rock deposition and hydrocarbon generation. Our poster presents snapshots from an ongoing project that addresses both shortcomings with examples from the South Atlantic conjugate margins.

Method and Examples

Plate models normally lack the definition apparent in our examples from bathymetry, gravity, magnetics, basement depth and sediment thickness (DEM-G-M-D2B-ST) grids. Vector representations of plate boundaries have often been digitized (best cases) from gravity imagery with 30 km resolution; transforms and spreading ridges have similar accuracies or worse. Our best global compilations provide resolutions of 5-7 km or better on our DEM-G-M grids and ~20 - 40 km on the D2B and ST grids. By reconstructing these rasters, we can see sub-basin detail that controls the interpretation of plate boundary features at the time of separation. We augmented a commercial software package from Rothwell that runs within ESRI's ArcView™ GIS to perform exact raster reconstructions of many data layers over large areas. We have recently run more than 40 data layers (including attributes, per Figure 1) for the entire South Atlantic including all of South America and Africa at 2 arc-minute (~3.7 km) resolution for ten paleoages from 65Ma to 206Ma (using the DNAG timescale). We can thus illustrate rift-age (or other age) geometries at sub-basin scale for vast areas at high detail.

We then proceed with reconstructed geochemical point data from the Brazil and African conjugate margins overlaid on the above high-resolution imagery. Key indicators of lacustrine paleo-environments have been developed in a series of steps since Schiefelbein *et al*., 1999. Both the number of points and the range of data extracted from each sample have increased. Multivariate statistical analysis (MSA) of geochemical results from ~1400 crude oils around the South Atlantic margins provides framework genetic oil-family relationships to distinguish source paleo-environments and age. Basin outlines and depocenters defined from constrained depth inversions illustrate containers that we match with oil families. Thus the elements of petroleum systems analysis are available to test inferences from the geochemistry. Our poster illustrates examples of MSA significance around the Atlantic margins, matching rift basin and sub-basin containers of conjugate petroleum systems.

Figure 1: Thumbnails of greater South Atlantic region paleo-reconstructions of all raster data layers to 94 Ma (Turonian-Cenomanian boundary, DNAG time scale).



Conclusions

We are thus able to define containers for specific oil sub-families that relate to their source depositional paleo-geographies. This both calibrates the geographic accuracy of plate models and the paleo-environmental inferences derived from such models. For conjugate margins with unequal exploration histories, we can apply inferences from one area to its mate, increasing the value of existing points in predicting exploration prospectivity.

References

Schiefelbein, C. F., Zumberge, J. E., Cameron, N. R., and Brown, S. W., 1999, Petroleum systems in the South Atlantic margins, The Geological Society, **SP153**, 169-179