Chapter 1 : Rift Basin Architecture & Evolution

Petroleum and Basin Evolution This book is a mosaic of important building blocks bringing together the evolution of petroleum and the dynamic geological framework of sedimentary basins. Both basin modeling and organic geochemistry serve important roles in this context.

Magmatism, Rifting, and Drifting 4. Jansa, Dalhousie University, Halifax, N. The sedimentary fill of rift basins represents the complex interaction among basin capacity accommodation space , sediment supply, available supply of water, and, in some cases, eustatic sea-level change see Figures 3. Within the realm of tectonics and basin evolution, our breakout group identified three important issues related to rift-basin development and the breakup of the Pangean supercontinent. Tectonic setting of eastern North American rifted margin, showing major Paleozoic compressional structures and early Mesozoic rift basins and key tectonic features of the eastern North Atlantic Ocean Benson and Doyle, ; Klitgord et al. Thick dashed lines and squares with notation show location of transects in Figure 4. Spatial variability of structure and stratigraphy within rift basins and rift systems The Triassic-Jurassic Pangean rift system, found on the conjugate continental margins of the central Atlantic Ocean, covers an enormous geographic area see Figure 2. Thus, the Pangean rift system would provide valuable information about the spatial variability of the structures and stratigraphy within rift basins and rift systems. Core data, supplemented with outcrop and seismic data, from these continental margins would allow us to address the following questions: Northwest-southeast regional cross sections through the passive margin of eastern North America. Sections show Paleozoic structures, early Mesozoic rift basins, and Mesozoic-Cenozoic postrift basins. Vertical axes are in two-way travel time. Section locations are shown in Figure 4. Transect through the eastern United States is based on geologic data from Shaler and Woodworth , Benson and Doyle , and Olsen et al. Click on the image above for a larger version. Sections through rift basins of eastern North America. Thick green lines mark contact between synrift strata of early Mesozoic age blue and prerift rocks of Precambrian-Paleozoic age unshaded. Thick red lines are fault surfaces. Arrows show Mesozoic movements. Vertical axes on seismic lines are in two-way travel time. Note inversion-related syncline in Minas subbasin. Note reverse faults and anticlines related to inversion. Note possible inversion-related syncline adjacent to eastern border fault. Inversion-related deformation pre-dates the Middle Jurassic unconformity. Note reverse faults and fault-propagation folds related to inversion. The Cooke fault was active as a reverse fault at the time of emplacement of the basalt because the footwall sequence is thicker than the hanging-wall sequence. Many Pangean rift basins have undergone inversion see Section 3. Questions related to this topic are: The final set of questions concerns spatial variations along the length of the rifted margin and from the landward to the seaward edge of the rifted margin Figure 4. Map of the junction of the Chignecto, Fundy, and Minas subbasins of the Fundy rift basin showing distribution of strata and rift- and inversion-related structures of early Mesozoic age, seismic coverage, and location of seismic lines illustrated in Figure 4. Offshore geology is based on seismic interpretation. Based on the results of NBCP, any potential coring target must satisfy the following requirements: Based on the science questions listed above, a coring target should also 1 contain known tectonostratigraphic packages; 2 contain known inversion structures; 3 contain known CAMP basalts; and 4 expand the geographic coverage beyond that of the NBCP. Arrows show only synrift sense of movement on faults. Red box shows approximate area of photo in c , showing faulted contact between Blomidon red beds and North Mountain Basalt. Triassic-Jurassic boundary is located a few meters below contact. Photo is representative of spectacular shoreline exposures in Fundy basin. Note that the stratigraphy of the pre-basalt formations is currently being revised. Coring Targets Based on the science questions and coring requirements outlined above, we have identified two attractive coring targets. Fundy Basin The Fundy rift basin Figures 4. There are abundant coastal outcrops that provide evidence of multiple tectonostratigraphic TS packages. Seismic data of variable quality are available from the Fundy basin Figure 4. These seismic data also provide evidence of multiple tectonostratigraphic packages, extensional deformation, and post-CAMP inversion. If necessary, new seismic data, including 3D seismic data, could be acquired. These seismic data would provide 3D information on basin geometry and its stratigraphic architecture, which would be helpful in siting the proposed core. Because of intense industry activity on the continental margin, the Fundy basin project offers the potential for industry partnership and ready access to the infrastructure needed for acquisition of new seismic data and coring. This would allow us to determine variations in stratal thickness and facies from the basin margins to the cored depocenter and would provide additional constraints on basin geometry and depositional architecture, which are necessary for basin-modeling studies. The conjugate margin for the Fundy rift basin is located in present-day Morocco. The Argana basin contains strata very similar to those in the Fundy basin. Tectonostratigraphic packages are also present in the Argana basin. Are these packages the same age on both margins? Are the unconformities between the packages of broadly similar ages? The Moroccan basins also contain a substantial postrift section which potentially allows us to better constrain the age of the inversion structures along this part of the margin. Both the Fundy and Moroccan basins exhibit more arid facies than those found in the Newark basin. This will allow us to explore latitudinal variation along the rifted margin. In this more arid setting, sediment influx is not primarily by moving water; there are important eolian and chemical inputs. Simplified sketches showing Withjack et al. Prior to Early Jurassic time, the southern basins stopped subsiding. In earliest Jurassic time, the southern region experienced NW-SE shortening, resulting in the development of small-scale reverse faults, folds, and possible basin inversion as well as the intrusion of NW-striking diabase dikes; seafloor spreading began; coevally, the northern basins were actively extending in a NW-SE direction, resulting in the intrusion of NE-striking dikes and accelerated subsidence c. By Middle Jurassic time, most of eastern North America was experiencing shortening, generally oriented NW-SE, which resulted in the development of small-scale reverse faults, folds, and basin inversion d ; seafloor spreading was now underway along most of the margin. If so, the volume of igneous material related to CAMP is enormous. Additional subsurface basalt flows extend as far west as Texas. Seismic data show that inversion structures affect the subsurface basalt flows Figure 4. The transect has two main objectives: This will help put the Clubhouse Crossroads basalt in a proper stratigraphic architecture Figure 4. When did rifting begin and when did it terminate? When did inversion begin? Whereas the northeastern U. Are these N- and NW-striking dikes related to a change in the stress regime from rifting to drifting? Or are they related to a complex stress field resulting from the separation of Africa from North America and South America from North America? New York, Elsevier, p. Seismic data acquisition, processing, and results, in Tankard, A. American Association of Petroleum Geologists Memoir 46, p. Geological Survey Professional Paper , p. Tectonic implications for the northern Appalachians: Canadian Journal of Earth Sciences, v. Atlantic continental margin; structural and tectonic framework, in Sheridan, R. Geological Society of America, p. Pierre and Miquelon, offshore Eastern Canada: Bulletin of Canadian Petroleum Geology, v. Atlantic margin, in Sheridan, R. Martins area, New Brunswick: Seismic evidence for extensive volcanism accompanying sequential formation of the Carolina trough and Blake Plateau basin: Penecontemporaneous faulting and sedimentation: Past and present, in Speed, R. New York, Columbia University Press, in press. Geological Survey Annual Report, No. Evidence of extension and shortening during passive margin development: An analog for other passive margins:

Chapter 2 : Basin Evolution (Supercontinent Breakup)

Petroleum and Basin Evolution: Insights from Petroleum Geochemistry, Geology and Basin Modeling by Dietrich H. Welte Petroleum and Basin Evolution This book is a mosaic of important building blocks bringing together the evolution of petroleum and the dynamic geological framework of sedimentary basins.

Tectonics of Rifting and Drifting: Rift basins have been increasingly the focus of research in tectonics, structural geology, and basin analysis. The reasons for this interest include: Thus, aspects of the evolution of these fault systems, including their nucleation, propagation and linkage, can be extracted from the sedimentary record. This section provides a brief overview of the rift basins related to Pangean breakup, especially those along the central Atlantic margin e. In particular, we examine 1 the structural architecture of rift basins; 2 the interplay of tectonics, sediment supply, and climate in controlling the large-scale stratigraphy of rift basins; 3 how the sedimentary fill can be subdivided into tectonostratigraphic packages that record continental rifting, initiation of seafloor spreading, basin inversion, and drifting; and 4 how coring can be used to answer fundamental questions related to these topics. Structural Architecture A typical rift basin is a fault-bounded feature known as a half graben Fig. In a cross section oriented perpendicular to the boundary fault transverse section , the half graben has a triangular geometry Fig. The three sides of the triangle are the border fault, the rift-onset unconformity between prerift and synrift rocks, and the postrift unconformity between synrift and postrift rocks or, for modern rifts, the present-day depositional surface. Within the triangular wedge of synrift units, stratal boundaries rotate from being subparallel to the rift-onset unconformity to being subparallel to the postrift unconformity. This fanning geometry, along with thickening of synrift units toward the boundary fault, are produced by syndepositional faulting. Core from the Newark basin confirms the thickening relationships see Section 3. Synrift strata commonly onlap prerift rocks. In a cross section oriented parallel to the boundary fault longitudinal section , the basin has a synclinal geometry Fig. Geometry of a simple half graben. The half-graben geometry described above is directly controlled by the deformation displacement field surrounding the boundary fault system Gibson et al. In a gross sense, displacement is greatest at the center of the fault and decreases to zero at the fault tips Fig. In traverse section, the displacement of an initially horizontal surface that intersects the fault is greatest at the fault itself and decreases with distance away from the fault. This produces footwall uplift and hanging-wall subsidence, the latter of which creates the sedimentary basin Fig. However, this geometry is affected by fault propagation and forced folding e. As displacement accumulates on the boundary fault, the basin deepens through time. Because the width of the hanging-wall deflection increases with increasing fault displacement Barnett et al. Because the length of the fault increases with increasing displacement e. The growth of the basin through time produces progressive onlap of synrift strata on prerift rocks Fig. Fault-displacement geometry controls the first-order geometry of a half graben. The yellow dashed line shows the outer limit of hanging-wall subsidence and marks the edge of the basin. The latter produces a wedge-shaped basin half graben. Simple filling model for a growing half-graben basin shown in map view stages , longitudinal cross section stages , and transverse cross section stages Dashed line represents lake level. The relationship between capacity and sediment supply determines whether sedimentation is fluvial or lacustrine. For lacustrine sedimentation, the relationship between water volume and excess capacity determines the lake depth. Modified from Schlische and Anders The simple structural architecture described above may be complicated by basin inversion, in which a contractional phase follows the extensional phase e. Typical inversion structures include normal faults reactivated as reverse faults, newly formed reverse and thrust faults, and folds Fig. Basin inversion occurs in a variety of tectonic environments e. The causes of inversion on these passive margins is not well understood. Examples of positive inversion structures. During inversion, normal faults became reverse faults, producing synclines and anticlines with harpoon geometries after Letouzey, During Miocene inversion, deep-seated normal faults became reverse faults. In response, gentle monoclines formed in the shallow, postrift strata. Experimental models of inversion structures. Cross sections through three clay models showing development of inversion structures after Eisenstadt and Withjack, In each model, a clay layer with colored sub-layers covered two overlapping metal plates. Movement of the lower plate created extension or shortening. Thin clay layers are prerift; thick clay layers are synrift; top-most layer is postrift and pre-inversion. Top section shows model with extension and no shortening; a half graben containing very gently dipping synrift units is present. The middle section shows model with extension followed by minor shortening; a subtle anticline has formed in the half graben, and is associated with minor steepening of the dip of synrift layers. Bottom section shows model with extension followed by major shortening. The anticline in the half graben is more prominent, and is associated with significant steepening of the dip of synrift strata. New reverse faults have formed in the prerift layers. Although the inversion is obvious in this model, erosion of material down to the level of the red line would remove the most obvious evidence of inversion in the half graben. Furthermore, the prominent reverse faults cutting the prerift units could be interpreted to indicate prerift contractional deformation, as is common in the rift zones related to the breakup of Pangea. Stratigraphic Architecture Numerous non-marine rift basins of varied geography and geologic age share a remarkably similar stratigraphic architecture Lambiase, ; Schlische and Olsen, ; Fig. Known as a tripartite stratigraphy, the section begins with basin-wide fluvial deposits overlain by a relatively abrupt deepening-upward lacustrine succession overlain by a gradual shallowing-upward lacustrine and fluvial succession. The key to understanding the significance of this tripartite stratigraphy rests in the relationships among basin capacity and sediment and water supply Schlische and Olsen, ; Carroll and Bohacs, Tectonics creates accommodation space or basin capacity. Sediment supply determines how much of that basin capacity is filled and whether or not lake systems are possible Figure 3. In general, fluvial deposition results when sediment supply exceeds capacity, and lacustrine deposition results when capacity exceeds sediment supply. Stratigraphic architecture of Triassic-Jurassic rift basins of eastern North America. For tectonostratigraphic TS package III, nearly all basins exhibit all or part of a tripartite stratigraphy: The southern basins do not contain TS-IV. TS-I is only recognized in the Fundy basin and may or may not be a synrift deposit. Modified from Olsen , Olsen et al. In example 1, basin-wide fluvial sedimentation is predicted. In example 2, shallow-water lacustrine sedimentation is predicted. For the basin capacity and available sediment supply shown in this example, no very deep lakes are possible because the excess capacity of the basin and thus lake depth is limited. Thus, under these conditions, climate is a relatively unimportant control on lake depth. In example 3, deep-water lacustrine sedimentation is predicted. The relationships shown in Figure 3. How do we go about choosing the more likely interpretation? Interestingly, all of the major stratigraphic transitions can be explained by an increase in basin capacity, for which a simple basin-filling model is shown in Figure 3. Other basin filling models are described by Lambiase , Smoot , and Lambiase and Bosworth As discussed in Section 3. Idealized rift basin showing unconformity-bounded tectonostratigraphic packages. Thin black lines represent stratal truncation beneath unconformities; red half-arrows represent onlaps. In eastern North America, TS-I may not be a synrift deposit, and thus the geometry shown here would be incorrect. Modified from Olsen Tectonostratigraphic Packages and Basin Evolution Olsen subdivided the synrift strata of central Atlantic margin rift basins into four tectonostratigraphic TS packages Fig. An individual TS package consists of all or part of a tripartite stratigraphic succession, is separated from other packages by unconformities or correlative conformities, and generally has a different climatic milieu compared to other TS packages. However, it is not yet clear if these unconformities are related to regional tectonic changes e. Given their geometry and location in the rift basin, TS-I and TS-II can generally only be sampled through deep coring and not the relatively shallow offset coring utilized in the Newark basin Section 3. The rift-onset unconformity between prerift rocks and various synrift units should not be taken as evidence of regional uplift preceding rifting; rather, it more likely reflects erosion and non-deposition occurring over a topographically elevated region resulting from the assembly of Pangea. Stages in the evolution of a rift basin. As discussed more fully in Withjack et al. The temporal and spatial relationships of these igneous rocks is a critical coring target; see sections 4. Thus, the end of rifting, the initation of inversion, and probably the initiation of seafloor spreading are diachronous along the central Atlantic margin i. Coring, field analysis, and seismic-reflection profiles of synrift and immediately overlying postrift deposits and the structures formed in them, are necessary to clarify the important events occurring at the rift-drift transition. The inferred diachronous initiation of seafloor spreading along the present-day margin of the central North America Ocean is part of larger trend that reflects the progressive dismemberment of Pangea. As the North Atlantic Ocean continued to develop, seafloor spreading propagated northward. For example, seafloor spreading between the Grand Banks and southwestern Europe began during the Early Cretaceous e. American Association of Petroleum Geologists Bulletin, v. Geological Society of London Special Publication 88, p. Balancing tectonic and climatic controls: Rifting history, basin development, and petroleum potential, in Parker, J. Geological Society of London, v. Journal of Geophysical Research, v. Geophysical Monograph , American Geophysical Union, p. Journal of Structural Geology, v. AAPG Memoir 50, p.

Chapter 3 : petroleum and basin evolution | Download eBook pdf, epub, tuebl, mobi

Petroleum and Basin Evolution Insights from Petroleum Geochemistry, Geology and Basin Modeling With Figures and 38 Tables i Springer.

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This book has been prepared by the collaborative effort of two somewhat separate technical groups: the researchers at the Institute for Petroleum and Organic Geochemistry, Forschungszentrum Jii- lich (KFA), and the technical staff of Integrated Exploration Systems (IES).

Chapter 5 : Get Petroleum and Basin Evolution: Insights from Petroleum PDF - Sanatorii Kislovodska E-bo

One of the most fundamental problems in basin modeling as related to petroleum exploration is assessing the temporal and spatial limits of petroleum generation in sedimentary basins. It is well.

Chapter 6 : Petroleum and Basin Evolution : Donald R. Baker :

This study presents a 2D basin model along a transect crossing the on- and offshore Tarfaya Basin, Morocco, in SE-NW direction. The aim of the project is to investigate the thermal evolution of.