THE GREAT RIFT VALLEYS OF PANGEA IN EASTERN NORTH AMERICA

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Tectonostratigraphy of the Orpheus Graben, Scotian Basin, Offshore Eastern Canada, and Its Relationship to the Fundy Rift Basin

Lawrence H. Tanner and David E. Brown

The Orpheus graben is an eastward-plunging and widening fault-bounded subbasin of the Scotian basin that shares a tectonic link with the nearby similar size Fundy rift basin. The formation of both basins resulted from reactivation of the Cobequid-Chedabucto fault by oblique-slip movement with a sinistral sense coincident with the initial rifting that formed the Scotian basin. Up to 8 km of Mesozoic sediment accumulated within the graben as a series of three tectonostratigraphic sequences distinguished by distinct changes in the rate of extension and basin subsidence. Tectonostratigraphic Sequence A1 consists of early Norian and older continental redbeds comprising fluvial-lacustrine conglomerates, sandstones, and shales deposited during an initial period of synrift sedimentation that are presumed present in the Orpheus graben, although not drilled, and present in the Fundy rift basin. Outcrops of coarse redbeds of Late Triassic age along the shores of Chedabucto Bay may represent laterally equivalent deposition at the western end of the graben. Continued extension caused basin expansion and increased accommodation space, resulting in a fining-upward transition to Sequence A2. Temporally equivalent strata in the two basins comprise fine-grained sandstones and mudstones containing desiccation and sandpatch features as well as minor evaporites deposited as playas and sandflats during the late Norian to earliest Hettangian. A pulse of accelerated extension in the early Hettangian led to widening of the rift system and invasion of the Tethys in the Orpheus graben. Sequence B1 in the Orpheus graben comprises evaporites predominately deposited during Hettangian to Sinemurian time following this restricted transgression. This period of extension may have caused the eruption of the Hettangian age flood basalts that characterize the Newark basins. These basalt flows and the overlying continental clastics comprise Sequence B1 in the Fundy rift basin. Continued basin subsidence during Sinemurian to Toarcian time caused more widespread transgression in the Orpheus graben, resulting in deposition of B2, comprising predominantly shallow marine clastics, carbonates, and evaporites, contemporaneous with continued continental clastic deposition in the Fundy rift basin. A regional unconformity may have resulted from the onset of active seafloor spreading in the Middle Jurassic, possibly causing compressive folding and faulting visible in outcrops and seismic sections in the Fundy basin and in outcrops at Chedabucto Bay. Sequence C comprises thin sequences of Mesozoic and Cenozoic marginal marine and shelf sediments deposited as seaward-thickening wedges during slow

passive-margin subsidence, burying the rift basins of the Scotian Shelf.

* * *

Studies of the Mesozoic rift-formed basins of eastern North America have tended to consider the origins and histories of the onshore and offshore basins separately. The detailed stratigraphy and sedimentology resulting from careful examination of outcrops onshore have found limited application in subsurface analysis of offshore basins; conversely, models of passive-margin development from regional stratigraphic studies of the continental shelf have had limited application onshore. Recent exceptions making the link between onshore basins and the continental shelf include Wade and MacLean (1990); Withjack, Olsen, and Schlische (1995); and Olsen (1997). Problems in comparison arise from the limited data available from most of the offshore basins, usually comprising drilling reports from wells that penetrate only a portion of the Mesozoic section and scattered seismic lines of limited quality due to salt movement. Seismic data of illustrative quality is particularly rare from the Orpheus graben.

This chapter examines the tectonostratigraphic history of the Orpheus graben, in part by comparison with the nearby Fundy rift basin. Aside from their proximity, the two basins share a northern boundary, the Cobequid-Chedabucto fault (CCF), which controlled basin development. This study demonstrates that the Orpheus graben and the Fundy rift basin have a common history of tectonostratigraphic evolution from their contemporaneous origination in the Middle to Late Triassic through the Middle Jurassic, at which point the developmental histories diverge. Olsen (1997) constructed a tectonostratigraphic architecture for the rift-formed basins of the central Atlantic margin (not including the Orpheus graben). Because questions remain about the age constraints on the initiation of sedimentation in the Fundy rift basin (P. E. Olsen, personal communication 1996), we rely on data from the Orpheus graben to construct a tectonostratigraphic architecture, which we then compare with the sequence of strata in the Fundy rift basin.

The Orpheus graben is a subbasin of the Scotian basin that forms a structural trough on the northern Scotian Shelf, widening and plunging eastward from Chedabucto Bay, south of Cape Breton, Nova Scotia, to the Laurentian subbasin (figure 4.1). Basin evolution paralleled that of the Fundy basin in that subsidence was initiated by movement on the CCF, a dextral Paleozoic transform that juxtaposes Meguma and Avalonian terranes and forms the northern boundary of the Fundy rift basin and the Orpheus graben. Reactivation by NW–SE extension with a sinistral-oblique sense was initiated during the Triassic coincident with the initial rifting of Pangea (Withjack, Olsen, and Schlische 1995). Initial extension by probable Middle Triassic (Anisian) time is dated by the fauna of the lower Wolfville Formation (Baird 1986; Olsen 1988). Although the palynology of well cuttings from the Orpheus graben establishes basin filling in the graben at least by Norian time (Lyngberg 1984), wells drilled in this graben have explored structural targets primarily on the basin flanks or salt structures in the basin center. Consequently, no wells have penetrated the entire stratigraphic section in the basin depocenters, leaving the timing of initial basin fill open to speculation.

TECTONIC SETTING

The Scotian basin comprises a complex series of mainly NE-trending half-graben and graben on the Scotian Shelf of eastern Canada initially filled by redbeds and salt (figure 4.1). Formation of the basin by the Middle Triassic, possibly earlier, marks the beginning of the rifting of Pangea and the formation of the modern Atlantic Ocean. The Orpheus graben differs in both size and orientation from other features in the Scotian basin. Extending up to 300 km east from the apex near the head of Chedabucto Bay and widening to as much as 60 km at the Laurentian subbasin, the Orpheus graben lies at an acute angle to the main structural trend of the basin.

The margins of the Orpheus graben have a complex geometry. The graben is bordered to the north by the CCF, interpreted by Tankard and Welsink (1989) as a southward-dipping listric fault with approximately 8 km of vertical displacement that soles out at the planar crustal boundary between the Avalon terrane to the north and the Meguma terrane to the south. The CCF separates the basin margin from the Scatarie Ridge to the north. A shallow half-graben block or series of blocks occurs locally to the south of the CCF, bounded to the south by a fault zone that is coincident

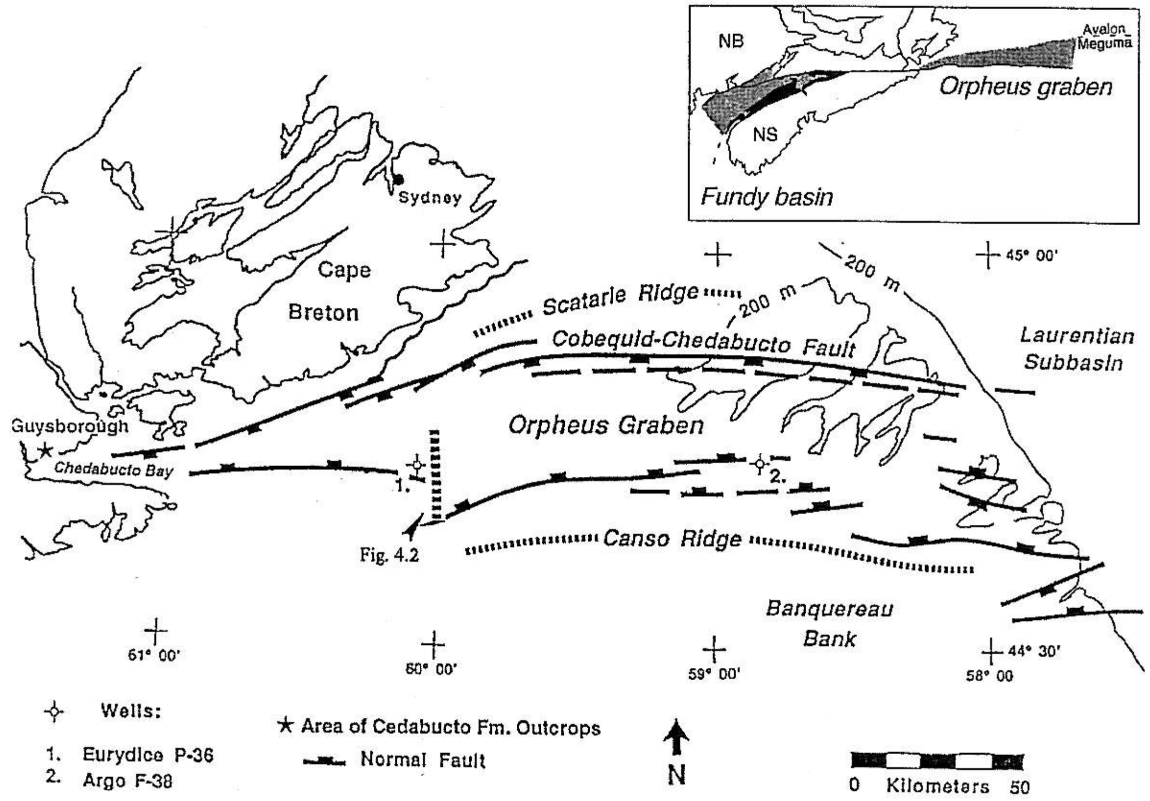

FIGURE 4.1 Tectonic and structural elements of the Orpheus graben. The terracing of the northern margin and the discontinuous nature of the southern border fault are apparent. Inset map shows relationship to the Fundy rift basin and other subbasins of the Scotian basin. The 200 m line is a bathymetric contour at the shelf edge. Line of dots indicates the location of the portion of the seismic line illustrated in figure 4.3.

with the regional hinge. A series of discontinuous faults antithetic to the normal displacement formed concurrent with extension, creating a terraced southern basin margin (Tankard and Welsink 1989). Within the basin, as much as 8 km of Mesozoic sediments accumulated on Meguma terrane basement blocks, thinned over a 3 km arch that separates the eastern and western depocenters (Wade and MacLean 1990).

TECTONOSTRATIGRAPHY

The Mesozoic strata of the Orpheus graben can be assigned to three tectonostratigraphic sequences, two of which are further subdivided in that they are distinguished by changes in rates of crustal extension and basin subsidence (figure 4.2). Sequences A and B can be matched with the stratigraphy of the Fundy basin to the west. Underlying the Mesozoic basin-fill sequence are a variety of lithologies, including metavolcanics and metasediments of the Cambrian to Ordovician Meguma Group and Paleozoic intrusives. Permo-Carboniferous sediments have not been drilled in the graben but are present on the Scatarie Ridge and so may also continue beneath the graben (Wade and MacLean 1990). Approximately 6 m of meta-argillite of the Meguma group were cored in the Argo F-38 well.

Sequence A

Tectonostratigraphic Sequence A comprises redbed clastics deposited during the initial stages of synrift basin fill in the Orpheus graben and the Fundy rift basin. In both basins, it is subdivided into a coarse lower unit (A1) and a fine upper unit (A2).

Sequence A1. Sequence A1 comprises predominately coarse fluvial clastics deposited during a stage of rapid sediment accumulation following initial basin subsidence. Active subsidence during deposition of these sediments is indicated by thickening of seismic reflectors into the border faults in the Fundy basin (With-

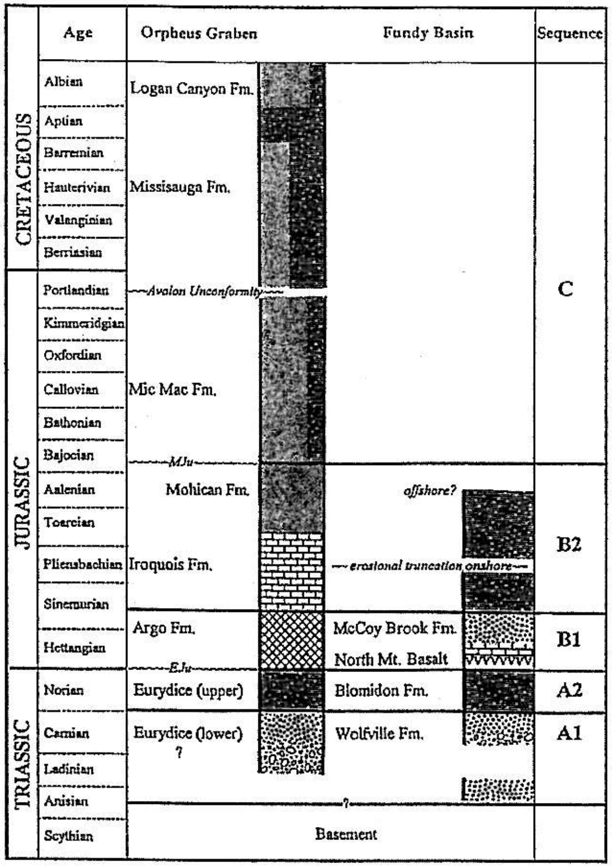

FIGURE 4.2 Generalized stratigraphy of the Orpheus graben and Fundy rift basin with corresponding tectonostratigraphic sequence boundaries. Precise ages of formation boundaries in the Orpheus graben are poorly constrained because most age control is from other locations on the Scotian Shelf, and the boundaries are likely diachronous.

jack, Olsen, and Schlische 1995), which may also be the case in the Orpheus graben, although the evidence is much less clear here due to the lower-quality seismic data. This sequence is represented in the Orpheus graben by the undrilled lower portion of the Eurydice Formation and in the Fundy rift basin by the Wolfville Formation.

The name Eurydice Formation is applied to redbed clastics that occur consistently at the base of the stratigraphic section in the subbasins of the Scotian basin. Several wells in the Orpheus graben have penetrated these redbeds of Late Triassic to Early Jurassic age. A total of 572 m of this formation was penetrated in the designated type well (Eurydice P-36) (figure 4.3), comprising nearly equal proportions (45% each) of reddish silty shale and of fine-grained sandstone and siltstone.

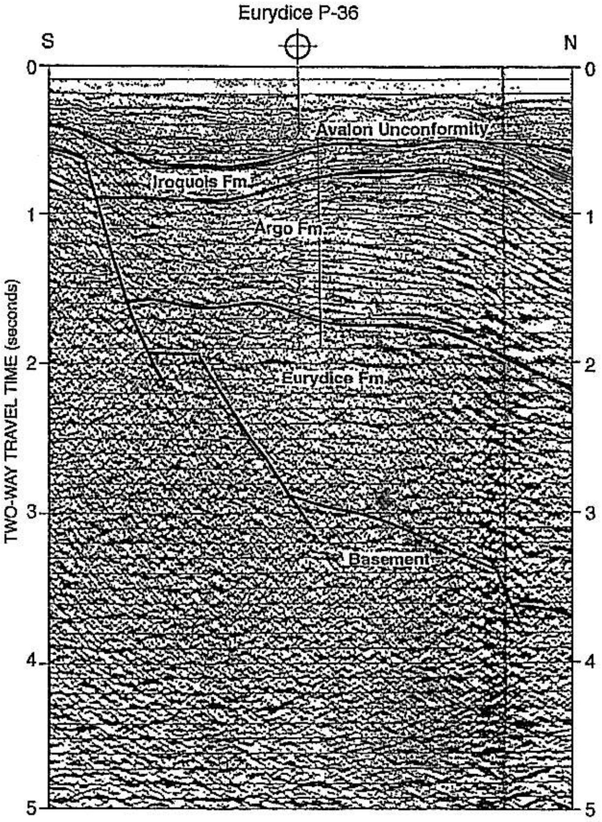

FIGURE 4.3 Portion of seismic line (Canada–Nova Scotia Offshore Petroleum Board File no. 81-415). The location is shown in figure 4.1. The position of the Eurydice P-36 well is illustrated. Formation boundaries are picked from well data. (Adapted from MacLean and Wade 1993)

From seismic data, the total thickness of the Eurydice Formation in the Orpheus graben is estimated at greater than 3 km (Wade and MacLean 1990). Coarser facies have been sampled in other wells in the Scotian basin. A 90 m coarsening-upward sequence in the Eurydice Formation, drilled to the southwest in the Emerald basin, is interpreted as a series of stacked channel sandstones (Wade and MacLean 1990).

Palynology of sparse samples from the Eurydice Formation penetrated by the type well documents that sedimentation was under way in the Orpheus graben by the Norian age (Jansa, Bujak, and Williams 1980), but the presence of nearly 2 km of section below the drilled interval suggests that sedimentation is likely to have begun prior to this period, perhaps as early as Carnian age or earlier. The irregular basement configuration along the north side of the Orpheus graben may have created isolated subbasins at the basin margin that preserve even older sediments. Sequence A1 in the Orpheus graben comprises coarse alluvial clastics of presumed Carnian–Norian age that are believed to occur in the lower Eurydice Formation.

Redbed clastics of the Chedabucto Formation (Klein 1960, 1962) that occur in scattered outcrops along the north shore of Chedabucto Bay comprise mudstones, sandstones, and conglomerates that may be laterally equivalent to the lower Eurydice Formation. No palynological data exist for these outcrops, although osseus remains have suggested a Late Triassic age (Klein 1962). A continuous 57 m section near the town of Guysborough (figure 4.1) consists of massive conglomerates, massive (badly weathered) to cross-bedded sandstones, and mudstones with root traces, calcareous nodules, and pedogenic slickensides. The beds of the coarse facies exhibit lateral thickness variations and basal scour, and are typically arranged in fining-upward sequences, suggesting deposition as a series of braided streams with intervening floodplain mudstones on which incipient caliche-type soils formed. Given the position of these outcrops at the apex of the Orpheus graben and their lithologic similarity to the Wolfville and equivalent formations in the Fundy basin, it is possible that this sequence represents a lateral equivalent to the undrilled lower part of the Eurydice Formation redbeds.

Synrift sedimentation initially comprising continental redbeds was likely synchronous in both the Fundy rift basin and the Orpheus graben, with initial sediment accumulation confined to isolated lows on an irregular fault-block topography. Sediments of the Wolfville Formation of the Minas subbasin appear to record the oldest sedimentation in the Fundy rift basin. One unique outcrop section on the northern margin of the Minas subbasin (the Lower Economy beds), comprising interbedded fluvial and eolian sandstones and minor lacustrine mudstones (Skilliter 1996), has been dated tentatively as Anisian on the basis of vertebrate remains (Baird 1986; Olsen 1988). The main body of the Wolfville Formation, comprising predominantly alluvial-plain deposits (Hubert and Forlenza 1988), is assigned an age of Carnian to Norian (Olsen 1988) and is presumed equivalent to the lower Eurydice beds. Olsen (1997) assigns the oldest portion of the Wolfville Formation to his tectonostratigraphic sequence (TS) I on the basis of temporal and facies distinction, and the bulk of the Wolfville Formation comprises his TS II. Because of the uncertainties in the age and lithology of the lower Eurydice beds, no such distinction can be made in the Orpheus graben. Sequence A1 is therefore equivalent to Olsen's (1997) TS I and TS II combined.

Sequence A2. Coarse or alternating coarse and fine clastics of fluvial origin—typical of initial synrift sedimentation in all the onshore Newark Supergroup basins (Olsen, Schlische, and Gore 1989; Smoot 1991; Olsen 1997)—are commonly succeeded by finer redbed lacustrine clastics deposited during the Norian and into the earliest Hettangian. This trend may reflect continued extension and basin growth during the Late Triassic, resulting in a decreased depositional gradient as accommodation space increases (Schlische and Olsen 1990). An alternative explanation is that gradual basin fill and outlet closure create a closed basin (Smoot 1991, 1995). Although the style of sedimentation changes from Sequence A1 to Sequence A2, no change in tectonic process or rate is envisaged as responsible for this transition.

Sequence A2 is recorded in the Orpheus graben by the penetrated (upper) portion of the Eurydice Formation. Approximately 8 m of core recovered from the Eurydice P-36 well comprise ripple-laminated sandstones up to 1.2 m thick that contain desiccation cracks and possible root traces; fine muddy sandstones with distorted ripple laminations; and mudstone beds up to 0.8 m thick in which desiccation cracks, sandpatch fabrics (*sensu* Smoot and Olsen 1988), and minor anhydrite nodules occur. Deposition in a terrestrial environment clearly is indicated. The presence of the sandpatch fabric, desiccation cracks, and anhydrite suggests an evaporative environment, possibly a saline (playa) mudflat. These facies closely resemble those of the age-equivalent (Norian–Hettangian) Blomidon Formation of the Fundy rift basin, interpreted as the deposits of interfingering saline mudflats and sandflats (Olsen, Schlische, and Gore 1989; Mertz and Hubert 1990; Ackermann, Schlische, and Olsen 1995). Sequence A2 is therefore defined as the sequence of fine-grained redbed clastics deposited during the Norian to early Hettangian, represented by the upper Eurydice Formation in the Orpheus graben and by the uppermost Wolfville and the Blomidon formations in the Fundy rift basin. The thickness of the upper Eurydice facies, relative to the formation thickness, cannot be estimated given the lack of well data and seismic resolution. This sequence corresponds to TS III of Olsen (1997).

Early Jurassic Unconformity

A regional Early Jurassic unconformity, termed a post-rift unconformity by Wade and MacLean (1990), is correlated across the Georges Bank, the LaHave platform, the Canso ridge, and the Mohican graben, separating deformed strata below from overlying undeformed strata. Recognition of this unconformity in the Orpheus graben is problematic due to the effect of salt tectonics on seismic reflections. The position of the unconformity, placed in the Hettangian, corresponds to the occurrence of volcanics drilled on Nantucket Island, in the Mohican graben (Wade and MacLean 1990), and in the Grand Banks (Pe-Piper, Jansa, and St. J. Lambert 1992). In the Mohican graben, the unconformity occurs above the Glooscap volcanics, which overlie thick evaporites of Carnian–Norian to Hettangian age. The age of these evaporites suggests that they are equivalent to the Osprey Formation of the Grand Banks (McAlpine 1990), a lateral equivalent of the Eurydice Formation, not to the younger Argo Formation. In the Orpheus graben, thick evaporites of the Argo Formation are Hettangian and younger and therefore occur above the presumed position of the unconformity. Although a Hettangian unconformity has not been recognized in the Fundy basin, evidence of extensional tectonism following Hettangian volcanism is present in the Minas subbasin (Schlische and Olsen 1990; Tanner and Hubert 1991; Ackermann, Schlische, and Olsen 1995; Withjack, Olsen, and Schlische 1995). Pe-Piper, Jansa, and St. J. Lambert (1992) suggest that crustal attenuation following a final period of extension created the pathways for the apparently synchronous eruption of the flood basalts of the eastern North America magmatic province. The regional unconformity recognized offshore may represent plate readjustment following this extension that primarily affected areas proximal to the central rift. Extensional widening of the main rift additionally may have caused an increased incursion of the Tethyan Sea in the Orpheus graben and in other basins on the Scotian Shelf.

Sequence B

Tectonostratigraphic Sequence B comprises volcanics and sediments deposited in the basins in the Early to Middle Jurassic following an extensional pulse in the Hettangian. This sequence is subdivided in the Orpheus graben on the basis of depth-related facies change.

Sequence B1. The volcanics of the eastern North America magmatic province, including the North Mountain Basalt of the Fundy rift basin, occurring at or above the Early Jurassic, are not recognized in the Orpheus graben, although their absence may be controlled more by the lack of well control from the deeper portions of the basin. Evaporite deposition was widespread throughout the Atlantic rift by Hettangian time, having begun by the end of the Carnian in some areas, as on the Grand Banks (Osprey Formation) and in the Mohican basin (Holser et al. 1988). Widening of the rift system in the Hettangian allowed deposition of the Argo Formation evaporites in the Orpheus graben. The Argo Formation is 780 m thick in the type well (Argo F-38) (MacLean and Wade 1993) but exceeds 5 km in thickness elsewhere in the graben. In general, the salt thickness is greater in the western parts of the graben than in the eastern parts and thins over the intervening basement highs. In the type section, the Argo Formation comprises predominantly massive beds of coarsely crystalline halite, up to 30 m thick, with occasional thin interbedded red anhydritic or dolomitic shales (Holser et al. 1988). The evaporites geochemically appear to have a dominantly marine source. The Eurydice P-36 well logs indicate that the formation contains a considerably greater clastic component in the proximal (western) end of the basin. The presence of potash salts (sylvite and nahcollite) here is interpreted also from the characteristics of sonic and gamma-ray curves for this well (Holser et al. 1988). The seismic character of this formation varies across the basin as well. Coherent reflections characterize those areas, primarily toward the west, in which the lithology comprises interbedded evaporites and clastics. Chaotic reflections predominate where the formation consists of massive halite.

The Argo Formation in the Orpheus graben is interpreted to be from late Hettangian to early Sinemurian based on palynology (Barss, Bujak, and Williams 1979). A change in palynomorphs from *Corollina meyeriana* to *C. classoides* near the Eurydice and Argo Formation boundary suggests a transition from a local terrestrial to a marine environment at this time (Lyngberg 1984). The mineralogy of the Argo Formation does not record a complete marine evaporative sequence, largely lacking sulfates, suggesting that deposition occurred in a restricted environment in which the waters were already sulfate depleted (Jansa, Bujak, and Williams 1980). The greater proportion of clastics and the presence of potash salts in the westernmost extent of the Orpheus graben confirm that this end of the basin was shallow and proximal to land, allowing greater clastic influx and more complete evaporation of the brines (Holser et al. 1988). The greater thickness of salt toward the western side of the basin may simply reflect postdepositional upslope migration of salt. Alternatively, greater subsidence of the distal end of the basin may have caused more normal marine deposition and a lessened proportion of evaporites (MacLean and Wade 1992). Salt diapirs and pillows are common in most subbasins of the Scotian basin, as are various salt-withdrawal structures, including arcuate listric faults.

The respective histories of the Fundy rift basin and the Orpheus graben remain tectonically linked during deposition of Sequence B1. Although the Tethyan invasion resulted in evaporite deposition in basins proximal to the rift margin, synrift clastic sediments (conglomerates, sandstones, and mudstones of fluvial, lacustrine, alluvial-fan, eolian, and playa origin) of the McCoy Brook Formation were deposited in the Fundy basin from the Hettangian at least to the Pliensbachian or possibly later (Traverse 1987; Tanner and Hubert 1992; Tanner 1996), above which the onshore section is truncated by erosion (Wade et al. 1996). In the two basins, Sequence B1 therefore comprises evaporites, volcanics, and continental clastics deposited following Hettangian extension. This sequence corresponds to TS IV of Olsen (1997).

Sequence B2. Continued subsidence of the Orpheus graben through the Early Jurassic and into the Middle Jurassic, possibly in concert with eustatic sea-level rise, eliminated restricted marine conditions. The Iroquois and partially coeval Mohican Formations overlie the Argo evaporites and were deposited at least in part penecontemporaneously with salt deformation. The maximum combined drilled thickness of these formations in the Orpheus graben is approximately 700 m, although this thickness represents an erosionally truncated interval penetrated by wells drilled on salt diapirs (MacLean and Wade 1993). The Iroquois Formation comprises carbonates, typically dolomitized, that attain a thickness of up to 1,600 m on the Scotian Shelf. In the type well in the Abenaki subbasin, the age is established as late Sinemurian to early Pliensbachian or younger (Wade and MacLean 1990). The Iroquois Formation appears to grade laterally into and is overlain by the clastic Mohican Formation and therefore may be a facies equivalent of the lower portion of the latter (Wade and MacLean 1990). The type section of the Mohican Formation in the Emerald basin comprises fine-grained sandstones and siltstones with interbedded red to green shales dated as Callovian age (Barss, Bujak, and Williams 1979). An age range of Aalenian, in places Pliensbachian, to early Bajocian age is demonstrated in several wells by palynology (Wade and MacLean 1990). The two formations cumulatively represent the completion of synrift basin fill.

Wade et al. (1996) interpret industry seismic data to conclude that postbasalt strata similar to the McCoy Brook Formation attain a thickness of more than 2.5 km in the depocenter of the Fundy rift basin and that an additional 2 km of sediments have been removed by erosion. Studies of the compaction of McCoy Brook Formation sandstones from onshore sections also suggest removal of up to 2 km of strata (Tanner 1996). Using an age range of early Hettangian to Pliensbachian (17 Ma) for the strata remaining, Wade et al. (1996) calculate a sedimentation rate of 15 cm per thousand years. Extrapolating this rate to the presumed original sequence thickness of 4.5 km, the authors conclude that postbasalt sedimentation lasted 30 million years, until the Aalenian. If correct, this missing strata would be temporally equivalent to Sequence B2 in the Orpheus graben, implying that subsidence and synrift sedimentation continued in the Fundy rift basin concurrently with the Orpheus graben.

Middle Jurassic Unconformity

MacLean and Wade (1992) interpret a significant unconformity within the Mohican Formation in the Abenaki and Laurentian subbasins. This unconformity may be Aalenian to Bajocian in age, and the overlying sandstones of the Mohican Formation may represent the base of the postrift sequence (Welsink, Dwyer, and Knight 1989). The unconformity is not clearly visible within the Orpheus graben, where it may be obscured by salt tectonics. Pe-Piper, Jansa, and St. J. Lambert (1992) associate the unconformity with major continental separation and with the onset of sea-floor spreading in the early Middle Jurassic. If so, this event would signal the change in tectonic regime from extensional to locally compressional, effectively ending rift-related basin subsidence.

The end of extensional tectonics and the onset of sea-floor spreading is likely responsible for the features of basin inversion (large-scale anticlines, reverse and thrust faults) described in the Fundy rift basin (Withjack, Olsen, and Schlische 1995; Wade et al. 1996). Similar structures are also present on a small scale in the Chedabucto Bay outcrops and are undoubtedly present in the Orpheus graben, although salt tectonics prevents their identification in seismic sections. Withjack, Olsen, and Schlische (1995) suggest that some structural features in other Scotian Shelf subbasins may in fact result from this inversion. This compressional event also may have been responsible for uplift and removal of much of the missing 2 km of Middle and Lower Jurassic sediment from the Fundy rift basin.

Sequence C

Accommodation space created by thermal subsidence of the drifting passive margin caused successions of late Mesozoic and Cenozoic clastics and carbonates to be deposited as a series of seaward-thickening wedges over the basin-fill sequence in the Orpheus graben following the Middle Jurassic unconformity. Sequence C is the first phase of purely postrift sedimentation following continental breakup. Clastics of the Mic Mac Formation (Bajocian to Portlandian) are separated from the overlying progradational wedges of the Cretaceous Missisauga and Logan Canyon Formations by the Avalon unconformity, a pronounced angular unconformity resulting from uplift of the Grand Banks following separation from Iberia (MacLean and Wade 1992). Much of the Upper and Middle Jurassic has been removed by erosion in the Orpheus graben, and there is no evidence of strata of this age in the Fundy rift basin. A period of Early Cretaceous volcanism resulted in flows interbedded with the Missisauga Formation (Jansa and Pe-Piper 1985). Passive-margin sedimentation continued through the Cenozoic.

CONCLUSIONS

The evolution of the tectonically linked Orpheus graben and the Fundy rift basin can be summarized by the following sequence of tectonostratigraphic events:

Synrift deposition of Sequence A1 followed initial extension and consisted of coarse alluvial redbeds. A1 is represented in the Orpheus graben by the lowermost Eurydice Formation, which may be as old as Carnian, and in the Fundy basin by the Anisian to early Norian Wolfville Formation and equivalents. Basin enlargement and increased accommodation space caused fining upward to lacustrine-mudflat deposits of A2, represented by the upper Eurydice Formation in the Orpheus graben and by the Norian uppermost Wolfville and the Norian to earliest Hettangian Blomidon Formation in the Fundy basin.

Deposition of Sequence B1 followed a pulse of renewed extension in the Hettangian. In the Orpheus graben, where extensional widening of the rift allowed a restricted invasion of the Tethyan Sea, Sequence B1 comprises evaporites of the Hettangian to Sinemurian Argo Formation. In the Fundy basin, this sequence comprises the Hettangian North Mountain Basalt and the overlying fluvial, lacustrine, eolian, and alluvial-fan clastics of the Hettangian to Pliensbachian McCoy Brook Formation.

The thinner carbonates and clastics of Sequence B2 mark the final phase of synrift sedimentation in the subsiding basins. This sequence is represented by the Iroquois and Mohican formations in the Orpheus graben and by the missing upper half of the McCoy Brook sequence in the Fundy rift basin.

An early Middle Jurassic unconformity marks the end of rift-related sedimentation as compression associated with the onset of sea-floor spreading halted basin subsidence and caused basin inversion in the Fundy basin and, possibly, in the Orpheus graben.

Shelf sedimentation on a thermally subsiding passive margin buried the offshore basins with seaward-thickening wedges of clastics and carbonates of Sequence C beginning in the Middle and Late Jurassic and continuing through the Cenozoic.

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