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Résumé de l'article

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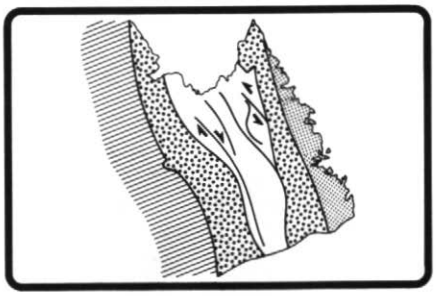

# Nappes in the internal zone of the northern Labrador Trough: Evidence for major early, NW-vergent basement transport

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**Summary**
The westernmost hinterland zone of the northern Labrador Trough is characterized by four NW-trending, Archean basement bodies overlain by an upward-coarsening, amphibolite-facies volcanosedimentary cover sequence correlative with the Kaniapiskau Supergroup of the Labrador Trough. Two of the gneissic basement bodies occur in antiformal cores, but two occur in the cores of synforms. The synformal gneisses are thought to represent the downfolded lower limb of a single, basement-cored nappe floored by a large thrust that roots down into one of the basement domes. The history of this area during the Hudsonian Orogeny involved initial westerly imbrication and transport of the cover succession along a thin décollement zone at the basement-cover interface. This was followed by NW-directed, basement-involved thrusting and associated folding, and large-amplitude, upright to SW-vergent, SE-plunging folding. The NW-vergent, basement-involved event appears to be restricted to this portion of the hinterland zone.

**Introduction**
Deformation in orogenic forelands generally features limited basement involvement (Price and Mountjoy, 1970; St-Julien *et al.*, 1983), but the same is not true of hinterlands. In this paper, we document large-scale, orogen-oblique, basement thrusting and folding

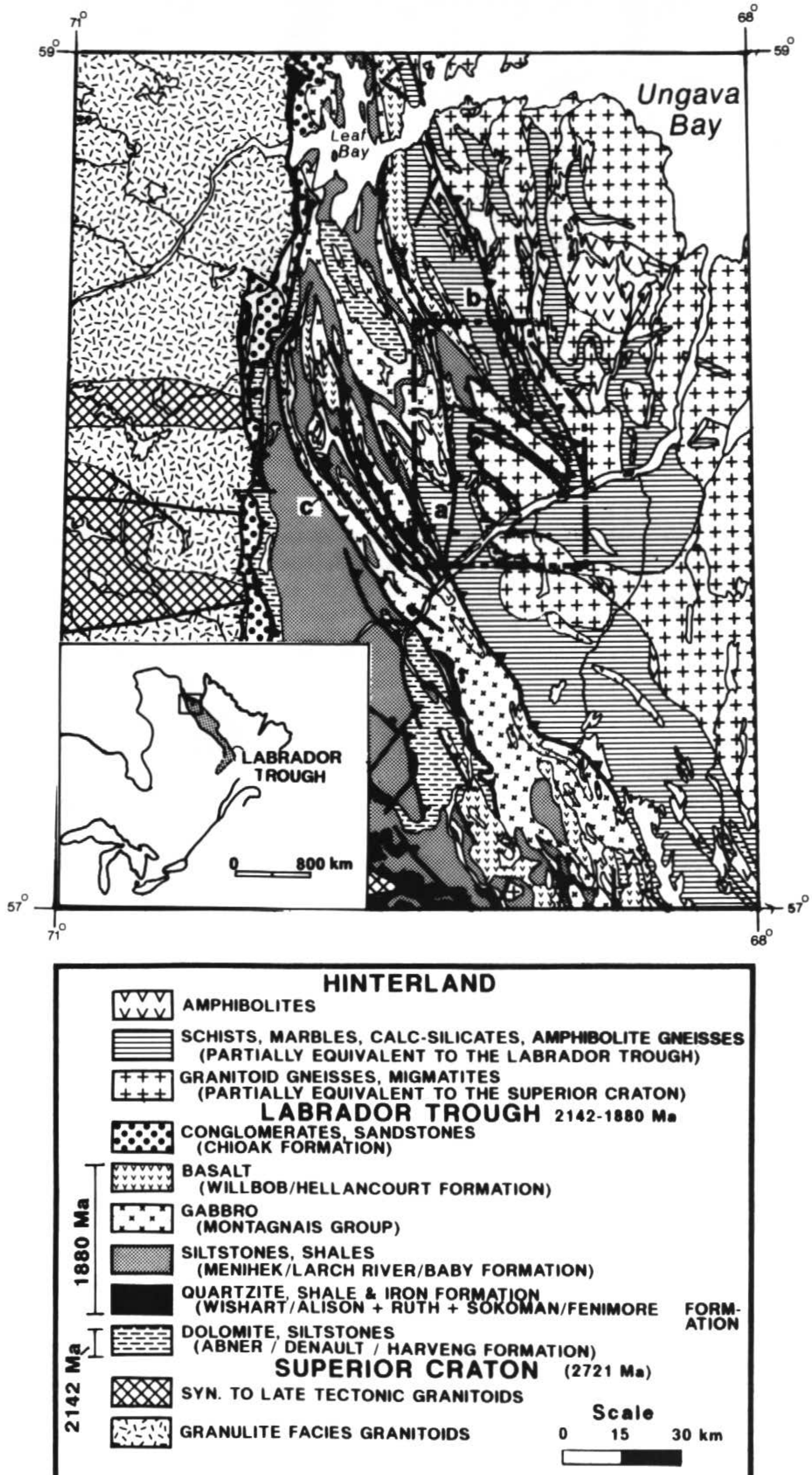


**Figure 1** *Geology of the northern Labrador Trough with the area of interest outlined; modified from Avramtchev (1985, 1990), Goulet (1987) and Boone and Hynes (1990). Fault* **a**, *Lac Rachel reverse Fault;* **b**, *Lac Olmstead dextral strike-slip fault; and* **c**, *Couteau Thrust. The autochthonous-parautochthonous zone extends from the Superior basement to the Couteau Thrust; the allochthonous zone from the Couteau Thrust to the Lac Rachel Fault; and the Hinterland or internal zone extends eastward from the Lac Rachel Fault.*

at an early stage in the structural evolution of the hinterland to the Early Proterozoic thrust-and-fold belt of the Labrador Trough. We then discuss its anomalous character in the context of the overall tectonics of the fold belt.

## General geology

The Labrador Trough, or New Québec Orogen, (Figure 1) consists of 2142 Ma (Dressler and Krogh, cited *in* Clark, 1984) to 1880 Ma (Chevé and Machado, 1988) sedimentary, volcanic and subvolcanic intrusive rocks deformed into a thin-skinned, WSW-vergent, thrust-and-fold belt (Séguin, 1969; Harrison *et al.*, 1970) during the Hudsonian Orogeny (1845–1770 Ma; Perreault *et al.*, 1988). In the northern Labrador Trough, the thin-skinned belt is truncated to the east by the steep, east-dipping Lac Rachel Fault (Sauvé and Bergeron, 1965; Moorhead and Hynes, 1986; Goulet, 1987) that juxtaposes folded and imbricated metamorphic rocks of the hinterland zone against the less deformed Labrador Trough (Moorhead and Hynes, 1986; Goulet, 1987; Moorhead, 1989; Poirier *et al.*, 1990).

## Local geology

The region of interest is bounded by the Lac Rachel Fault to the west and by the steeply east-dipping Lac Olmstead Fault to the east (Figure 2). Both faults have been interpreted to have dextral strike-slip motion (Goulet, 1987), although metamorphic contrast across the Lac Rachel Fault indicates a probable reverse component.

The region contains four NW-trending, *en échelon* bodies of Archean (2883–2868 Ma, Machado *et al.*, 1989) basement gneiss overlain by an amphibolite-facies volcano-sedimentary assemblage. The overall map pattern results from a series of NW-trending antiforms and synforms (Figure 2). The most northerly of the Archean bodies, the Boulder Gneiss, forms an elongate, NW-trending, doubly-plunging, upright to SW-overturned dome (Gélinas, 1965), whereas the Renia Gneiss adjacent to it forms a NW-trending, elongate, upright to SW-overturned, basement-cored synform. The Moyer Gneiss forms an elliptical dome (Clark, 1980) and the Scattered Gneiss forms a NW-trending, SE-plunging, upright synform (Clark, 1980).

The Renia Gneiss is enveloped at its NW termination by a 2.7 km thick, overturned supracrustal succession that can be confidently correlated with the Kaniapiskau Supergroup (Labrador Trough) west of the Lac Rachel Fault (Sauvé and Bergeron, 1965; Moorhead and Hynes, 1986; Moorhead, 1989; Poirier *et al.*, 1990). The Renia synform, therefore, preserves a complete basement-cover succession, similar to that which must once have underlain the deeper parts of the thin-skinned Labrador Trough farther west.

## Deformation events

The present structure of the region can be attributed to several distinct, but not necessarily temporally discrete, events. A first event, $D_1$, gave rise to a basal (basement-cover) décollement surface, thrust faults and rare folds (Figure 3). The most common $D_1$ feature is a bedding-subparallel schistosity. The Renia Gneiss adjacent to the cover sequence displays a one-metre-thick, high-strain zone, with extreme grain-size reduction and very fine (mm-scale) layering, which is interpreted to result from deformation along the décollement. Rare asymmetric folding in the lowermost dolomitic marbles indicates a topside-westward motion along this fault. There are three major $D_1$ thrusts within the cover succession NW of the Renia Gneiss that are cut by the $D_2$ thrust (Figure 2).

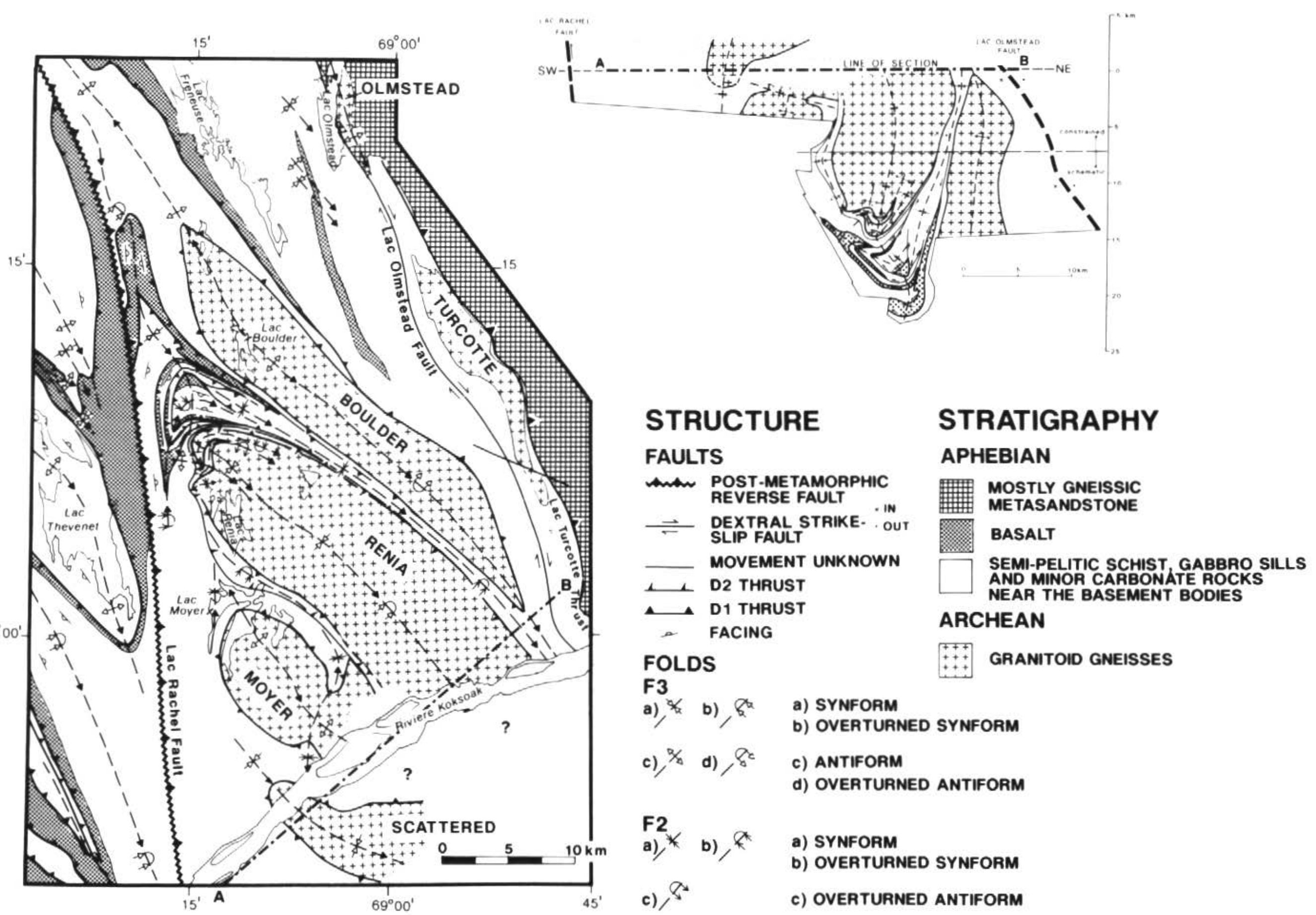


**Figure 2** *Structural map and composite down-plunge section of the western internal zone of the northern Labrador Trough; the map is modified from Sauvé and Bergeron (1965), Gélinas (1965), Clark (1980), Goulet (1987), Avramtchev (1990) and Poirier* et al. *(1990).*

The large, gneiss-cored nappe is thought to have formed during $D_2$. There are several smaller-scale $D_2$ folds. At the NW termination of the Renia Gneiss, the cover succession is folded by a large, steeply plunging, upright syncline that encircles this portion of the gneiss body. A cover-cored isoclinal antiform infolds the cover into the basement on the SW flank of the Renia Gneiss. The southern portion of the Moyer Dome is infolded by a NW-trending, cover-cored syncline. The $F_2$ structures refold the $S_1$ schistosity and the $D_1$ thrust faults. The mesoscopic $F_2$ folds display rounded closures and rare axial-planar cleavage. A stretching lineation is developed locally in the hinge zones and is subparallel to $F_2$ axes. Fold attitudes are variable. In areas of low strain, such as the core of the Moyer Dome, $F_2$ folds have NE-trending sub-horizontal axes and shallow, SE-dipping axial planes. At the NW termination of the Renia Gneiss, both the axial planes and the fold axes steepen markedly. One large $D_2$ thrust encircles the NW closure of the Renia Gneiss and roots down into the NE flank of the Moyer Dome (Figure 2). It carries the downward-facing Renia basement nappe in its hanging wall and cuts the limbs of several $F_2$ folds. Drag folds at all scales in the hanging wall and footwall blocks of the thrust are compatible with a northwesterly motion. The minimum displacement on this thrust is on the order of 25 km (Figure 2).

The NW-trending antiforms and synforms that dominate the structural style of the region were formed in $D_3$. $F_3$ folds have NW-trending, upright to NE-dipping, axial planes and steeply to moderately SE-plunging fold axes. They are similar to the large-scale NNW-trending folds in the central zone of the Labrador Trough farther west (Goulet, 1987; Boone and Hynes, 1990).

The original shape of the $D_2$ Renia nappe can be seen by removing the effects of $F_3$ folding. This was done by unfolding the $F_3$ synform and rotating the fold axis to the horizontal about a NE-trending horizontal axis. $F_2$ fold axes on the SW limb of the Renia synform rotate into an easterly trend, whereas $F_2$ axes on the NE limb rotate into a southeasterly trend. The simplest explanation for the divergence of $F_2$ fold axes is that they were formed parallel to the curvilinear nose of the Renia nappe, indicating that it had a sheath-like geometry. The long-axis of the sheath-like nappe must have been coincident with the trace of the $F_3$ synform that presently forms the core of the Renia Gneiss (Figure 3). Its geometry appears to have been influenced by precursors to the later ($F_3$) Boulder and Moyer domes.

The pre-$D_3$ morphology of the Renia nappe, and its position relative to the two later domes, may be explained by its growth from the SE-dipping portions (backs) of pre-existing basement highs. The sheath-like form of the Renia nappe may then be simply an inheritance from the form of surface on which it nucleated.

## Discussion

Formation of the Renia nappe requires a large amount of early, NW-directed thrusting and crustal thickening in the westernmost hinterland of the northern Labrador Trough. This is in marked contrast to the prevalent WSW- to SW-transport in the adjacent central and western portions of the northern Trough. The NW-vergent $D_2$ structures are also difficult to reconcile with current models involving early, large-scale, dextral strike-slip motion in the hinterland zone (Goulet, 1987; Hoffman, 1990). The orogen-parallel component of the NW-directed $D_2$ event would require a sinistral motion. This does not, however, preclude later, dextral strike-slip motion during $D_3$, and indeed the large-scale curvature of the $F_3$ folds bounded by the Lac Olmstead and Lac Rachel faults seems to indicate this (Figure 2).

It is possible that the northwesterly transport directions are of only local significance, and were controlled by a major lateral ramp structure. Such large-scale ramps might have arisen by extensional faulting that occurred during the initial rifting of the Labrador Trough (*cf.* Lister *et al.*, 1986). Alternatively, the $D_2$ structures in this region may reflect a compressional event that was experienced elsewhere along tectonic strike in the orogen prior to major strike-slip translation of the block into its present position. There is, however, little evidence elsewhere in the Labrador Trough for such NW-directed transport, or for the sinistral transpression that might have given rise to it. The hinterland is, however, as yet poorly known. Phanerozoic orogens such as the North American Cordillera (Avé Lallemant and Oldow, 1988) also provide abundant evidence for reversal of transcurrent shear sense during their evolution.

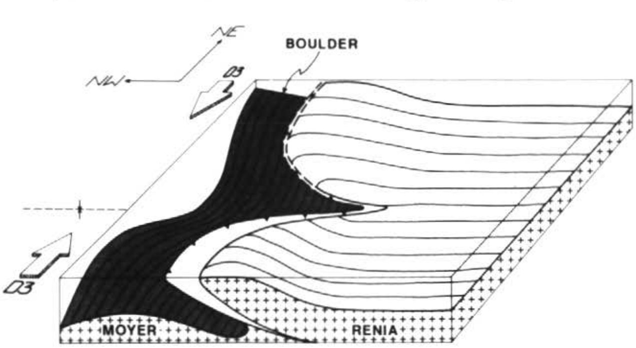


**Figure 3** *Schematic pre-$D_3$ configuration of the Renia nappe and underlying basement.*

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This study forms part of an MSc thesis (JM) at McGill University. Financial support to JM was provided by an FCAR scholarship and a Max Bell Award. Natural Sciences and Engineering Research Council and FCAR operating grants to A.H. are also acknowledged. Field work was performed under the supervision of Normand Goulet, who is warmly thanked for his involvement in this study, and supported by the Ministère de l'Énergie et des Ressources du Québec. Comments by Ghislain Tourigny, Brendan Murphy and an anonymous reviewer helped to clarify several points and are gratefully acknowledged. Ministère de l'Énergie et des Ressources du Québec contribution nº 90-5110-17.

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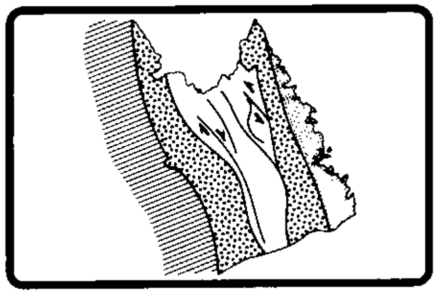

# Deformational style in the foreland of the northern New Québec Orogen


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**Summary**

The northern segment of the New Québec Orogen is divided into 4 zones, based on lithostratigraphic assemblages and deformational style. The tectonic fabric is the result of WSW-SW transport during the third deformation event, which, in the foreland, consists of two stages. A basal décollement, low-angle thrust faults and bedding-parallel gliding in the western foreland are important features of the early $D_3$ stage. The bulk of crustal shortening occurred during the late $D_3$ ($D_{3'}$) stage, which is characterized by large-scale, high-angle out-of-sequence thrusts, and folds. The hinterland records more complex pre-$D_{3'}$ deformation, which cannot presently be correlated with early deformation in the foreland. The $D_{3'}$ out-of-sequence geometry is probably the result of syntectonic erosion of the orogenic wedge, but there is little geological evidence in the foreland supporting this premise. This apparent paradox can be explained by invoking a two-sided, double-wedge orogenic model, which links erosion and uplift in the hinterland to out-of-sequence thrusting in the foreland.

**Résumé**

La partie septentrionale de l'orogène du Nouveau-Québec se divise en quatre zones en fonction des assemblages lithostratigraphiques et du style structural. Le grain tectonique régional résulte d'un transport de ces zones vers le WSW-SW lors de la troisième phase de déformation qui comprend, dans l'avant-pays, deux phases. La phase précoce ($D_3$) est caractérisée par un décollement basal et des chevauchements en série dans la partie est de l'avant-pays et par des glissements parallèles aux strates dans la partie ouest. La phase tardive ($D_{3'}$), surtout responsable de l'épaississement crustal, est caractérisée par un ensemble généralisé de grands plis et de failles de chevauchement hors série abruptes. L'arrière-pays présente des structures pré-$D_{3'}$ plus complexes qui ne peuvent être corrélées avec celles de l'avant-pays. L'agencement hors-série $D_{3'}$ provient probablement de l'érosion syn-orogénique du prisme tectonique, mais on observe peu d'évidence de cette érosion dans l'avant-pays. Cette disparité correspond peut-être au modèle de double prismes tectoniques opposés, qui relie l'érosion et le soulèvement de l'arrière-pays aux chevauchements hors série de l'avant-pays.


## Introduction

Most studies of the New Québec Orogen (NQO), previously known as the Labrador Trough Orogen (Hoffman, 1988), have focussed on the central (lat. 54°–57°N) and southern portions of the fold belt (*e.g.*, Dimroth, 1978, 1981; Dimroth and Dressler, 1978; Wardle and Bailey, 1981; LeGallais and Lavoie, 1982). Until recently, little attention had been paid to the northern segment of the orogen and, with few exceptions, existing maps were lithological in nature and had escaped detailed structural interpretation.

This paper summarizes field and compilation work begun in 1986 as part of a regional metallogenic synthesis of the northern NQO funded by the Ministère de l'Énergie et des Ressources du Québec (MERQ)(Wares *et al.*, 1988; Wares and Goutier, 1989, 1990). The project includes a 55 km by 100 km segment of the foreland of the orogen (Figure 1). Detailed mapping in selected sectors, compilation of MERQ geological maps and of data from Budkewitsch (1986), Goulet (1987) and Boone (1987), and integration of Landsat TM and airborne vertical magnetic gradient data (Rheault, 1989) has permitted resolution of the stratigraphy and structure of the area.

The NQO separates the Archean Superior Province to the southwest from the Archean/Proterozoic Rae Province to the northeast. The orogen comprises three NNW-trending volcano-sedimentary belts (Figure 1), defining the "Labrador Trough", and a broad, poorly defined metamorphic-plutonic hinterland within the Rae Province. The tripartite assemblage of rocks is Early Proterozoic in age (≈2145–1875 Ma; Clark and Thorpe, 1990; Machado *et al.*, 1989) and was deformed during the Hudsonian Orogeny (≈1845–1785 Ma; Machado *et al.*, 1989; Perreault *et al.*, 1988).

The foreland (Labrador Trough) assemblage consists of three cycles of sedimentation and/or volcanism separated by unconformities. The lower two cycles are widely interpreted as passive margin sequences thickening toward the east (Dimroth, 1981; Wardle and Bailey, 1981; LeGallais and Lavoie, 1982; Clark and Thorpe, 1990), while the upper cycle consists of a syntectonic fluvial