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The Age of the Acadian Deformation in Maine-New Brunswick*

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Introduction

The distribution of deformed Upper Silurian to Devonian strata was widely known by the beginning of the 20th century (Jackson, 1837; Hitchcock, 1861; Logan, 1865; Williams and Gregory, 1900). None of the early workers named the mid-Devonian deformation during which the strata of the Maine-New Brunswick region were folded and cleaved. The name Acadian was introduced by Charles Schuchert (Schuchert, 1923; Longwell et al., 1932) from the Chaleur Bay region of New Brunswick-Gaspé. He defined the event as a disturbance that ".....culminated near the end of the [Devonian] period in the folding and uplift of a second generation of Appalachian Mountains...." (Longwell et al., 1932, p. 72).

The Acadian deformation is now considered as a Middle and early Late Devonian event consisting of a number of phases (Boucot et al., 1964; Boucot, 1968; Poole et al., 1970). Boucot et al. (1964) suggested that the first intense phase was of Late Emsian age in Maine and Quebec and was followed by one or more weaker phases terminating during Late Devonian time. A number of workers have recently published data indicating that the intense phase of the Acadian deformation had occurred in Early Devonian time (Rodgers, 1970; Spooner and Fairbairn, 1970; Naylor, 1971; Reynolds et al., 1973; Cormier and Smith, 1973; Pajari et al., 1974).

The stratigraphic, structural and/or radiometric data from eastern Maine, New Brunswick and adjoining areas of Québec (Fig. 1) suggests that the age of intense deformation phase of the Acadian deformation occurred in Early Devonian time in southwestern New Brunswick and adjacent Maine, and affected progressively younger rocks northward to the St. Lawrence River.

Geologic and Radiometric Data

The age of the intense Acadian deformation can be limited by deformed and undeformed rocks representing a relatively short time interval at four locations in Maine and New Brunswick (Table 1). Four other locations in Maine and Québec provided a maximum age on the basis of palaeontologically dated and deformed strata. The stratigraphic information is summarized in Table 1 and some stratigraphic relationships are shown diagramatically in Figure 2.

In the Eastport area, Maine, and in adjacent New Brunswick (Table 1, Fig. 2A), deformed Eastport and Pembroke strata of Gedinnian and Pridolian age respectively are intruded by undeformed igneous plutons. The Eastport is considered to be Gedinnian in age by Berry and Boucot (1970) and Berdan (1971). The underlying Pembroke Formation contains brachipods (Boucot et al., 1966) and ostracods (Berdan, 1971) of Pridolian age. Whole rock Rb-Sr isochrons from volcanic rocks in the Eastport and Pembroke Formations yielded ages of 412±5 and 410±14 my respectively and the undeformed plutons have been radiometrically dated by a number of methods in various laboratories (Table 2) giving an average age of 397 my. The Rb-Sr whole-rock age of the Silurian-Devonian boundary is approximately 410 my, which is about 15 my older than the time scale used in Table 1 (Harland et al., 1964). The radiometrically determined time interval between the deformed strata and the undeformed plutons, during which two deformation phases (Ruitenberg, 1968; Donohoe, 1973) of the Acadian orogeny had occurred (Pajari et al., 1974), is also approximately 15 my. Starting in the Gedinnian, this radiometric time interval would extend into the Siegenian, thereby dating the Acadian deformation.

In the Shin Pond - Katahdin (Fig. 2B) and Presque Isle (Fig. 2C) regions of Maine, the age of deformation is bracketed stratigraphically. The undeformed Trout Valley Formation at Katahdin contains excellent flora of Siegenian to Emsian age (Andrews and Kasper, 1970), and clasts of the underlying deformed Traveler Rhyolite in the basal beds. The youngest deformed unit with reliable palaeontologic dates is the Matagamon Sandstone of late Siegenian age (Boucot, 1968) which is overlain by the deformed Traveler Rhyolite. A similar

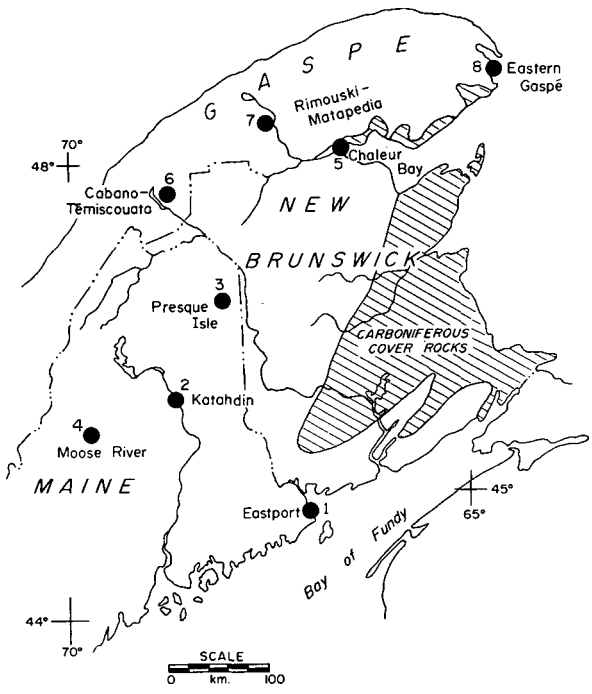

Fig. 1 Area of Carboniferous cover rocks.

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TABLE 1

Table 1 - Stratigraphic Sections

SYSTEM	European Section Series or Stage	① EASTPORT, MAINE, FUNDY COAST	② KATAHDIN-SHIN POND AREA, CENTRAL MAINE	③ PRESQUE ISLE, EASTERN MAINE	④ MOOSE RIVER, WESTERN MAINE	⑤ CHALEUR BAY N.B.	⑥ CABANO-TEMISCOUATA, QUEBEC	⑦ RIMOUSKI-MATAPEDIA, QUEBEC	⑧ EASTERN GASPE, QUEBEC	European Section Series or Stage
MISSISSIPPIAN	Tournaisian									Tournaisian
DEVONIAN Upper	Famenian	Perry				Escuminac			Malbaie	Famenian
DEVONIAN Upper	Frasnian		Trout Valley	Mapleton		Fleurant	Témiscouata	Lake Branch	Battery Pt.	Frasnian
DEVONIAN Middle	Givetian		Traveler Rhy.		Tomhegan	Pirate Cove		York River	York River	Givetian
DEVONIAN Middle	Eifelian		Matagamon		Kineo Rhy.	La Garde		north: Cap Bon Ami	Grand Greve	Eifelian
DEVONIAN Middle	Emsian		Seboomook	Dockendorf Group (Hedgehog)	Seboomook	Dalhousie Group	Touladi Lms.	south: Fortin Group	Cap Bon Ami	Emsian
DEVONIAN Lower	Siegenian	Eastport	Mafic Volcanic Rocks		Parker Bog & Whiskey Qtzt.		Mt. Wissick Group			Siegenian
DEVONIAN Lower	Gedinnian	Pembroke	Calcareous Siltstone		Lobster Lake and Hardwood Mt.	Chaleur Bay Group	Asselin	St. Leon	St. Albans	Gedinnian
SILURIAN Upper	Pridolian	Edmunds	Limestone	Perham Frenchville			Pt. aux Trembles	Sayabec		Pridolian
SILURIAN Upper	Ludlovian	Dennys	Siltstone				Cabano	Val Brillant		Ludlovian
SILURIAN Lower	Wenlockian	Quoddy	Conglomerate	Sprague-ville				Awantjish		Wenlockian
SILURIAN Lower	Llandoverian C6 B2 A1			Carys Mills						Llandoverian C6 B2 A1
ORDOVICIAN Upper	Ashgillian		Wassataquoik Chert and Shin Brook	Pyle Mt.		Elmtree Group		Matapedia Group	Quebec Group	Ashgillian
ORDOVICIAN Upper	Caradocian									Caradocian
ORDOVICIAN Upper	Llandeilian									Llandeilian

345 353 359 370 374 390 395 440 445

Column

1 Bastin and Williams, 1914; Boucot et al, 1966; Berden, 1971; Pajari et al, 1974
2 Neuman, 1967; Boucot, 1968; Kasper and Andrews, 1970
3 Boucot et al, 1964; Boucot, 1968
4 Boucot, 1961, 1968
5 Alcock, 1935; Dineley and Williams, 1968a,b; Poole et al, 1970; Brideaux and Radforth, 1970
6 Boucot, 1968; Lésperance and Greiner, 1969
7 Béland, 1960; Boucot, 1968
8 McGerrigle, 1950; Boucot et al, 1967; Boucot, 1968; McGregor, 1973

* Time scale by Harland et al, 1964 • fossil control \\\\ unconformity /\/\/\/\ Acadian Deformation

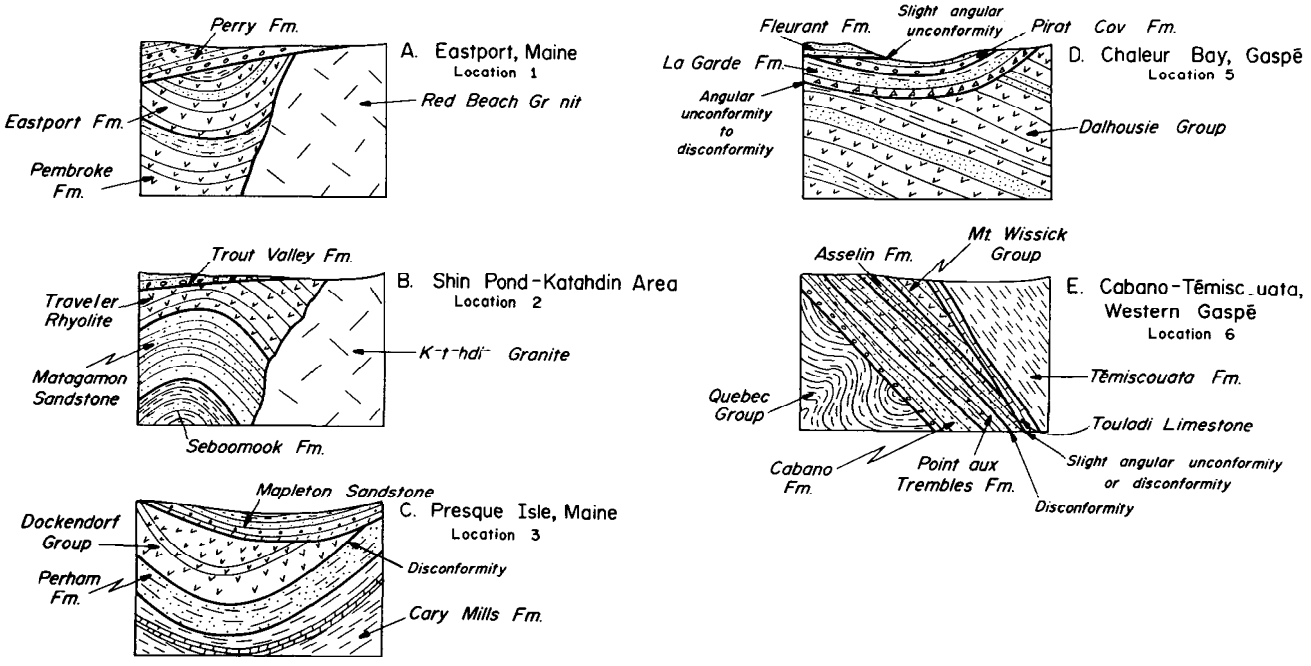

Fig. 2. Structural sections.

Table 2 - Radiometric Age Dates from the Eastport Area, Maine

ROCK UNIT	LITHOLOGY	RADIOMETRIC AGE IN MILLIONS OF YEARS	REFERENCE	
St. George Complex	gabbro, adamellite, granodiorite	394±20 Rb-Sr whole rock 391±22 K-Ar hornblende 385±11 K-Ar biotite	Pajari and others (1974) Wanless and others (1973)	Undeformed intrusions which truncate Acadian Structures
Red Beach	granite	393±6 Rb-Sr mineral isochron 401 K-Ar biotite 407 K-Ar biotite	Spooner and Fairbairn (1970) Faul and others (1963)	
Meddybemps	quartz monzonite	404 K-Ar biotite		
Charlotte	quartz monzonite	390 Rb-Sr biotite 406 K-Ar biotite		
Red Beach, Meddybemps, and Charlotte Intrusions		400 Rb-Sr whole rock	Spooner and Fairbairn (1970)	
ACADIAN OROGENY				
Eastport Fm.	red and gray shale, diabase flows and tuff	412±5 Rb-Sr whole rock	Bottino and Fullagar (1966)	Deformed Strata
Pembroke Fm.	red shale at top, grey at bottom andesite	410±15 Rb-Sr whole rock		
Dennys Fm.	felsic volcanic rocks	415±15 Rb-Sr whole rock		
Quoddy Fm.	black shale sandstone, intermediate volcanic rocks	420 15 Rb-Sr whole rock		

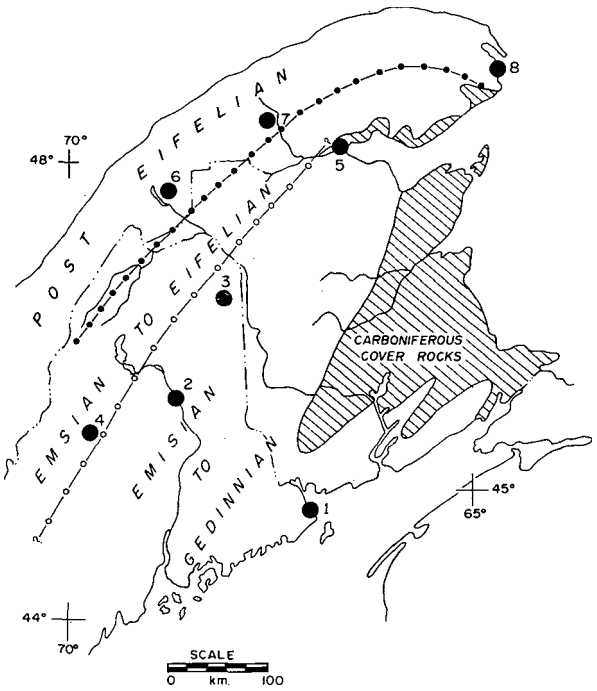

Fig. 3. Ages of Acadian deformation.

situation exists at Presque Isle where the Mapleton Sandstone of Emsian to Eifelian age (Scho f in Boucot et al., 1964; Forbes, personal communication, 1974) overlies more strongly deformed rocks of the Dockendorf Group (Siegenian). Both the Dockendorf Group and the Silurian rocks have undergone one period of folding.

In the Katahdin area, Naylor et al. (1974) have reported a preliminary Rb-Sr whole rock age of 395 my for the undeformed Katahdin Batholith which intrudes the deformed Traveler Rhyolite. Clearly, this radiometrically determined minimum age of the Acadian deformation is at variance with the palaeostratigraphically bracketed Emsian age (Table 1). However, a Rb-Sr whole-rock age previously obtained from the Traveler Rhyolite gave 353 my (Fullagar and Bottino, 1968). Since there is no way of resolving this contradiction at this time, we tentatively accept the possibility that the Acadian deformation occurred between Early Siegenian and Late Emsian time in this area.

In western Maine, Boucot (1961, 1968) has found the youngest deformed unit in the Moose River Synclinorium to be the Tomhegan Formation of Emsian age (Table 1) and therefore the deformation was post-Emsian. Only one deformation manifested by folds and cleavage affected the Silurian and Devonian rocks.

In northern New Brunswick on Chaleur Bay (Fig. 2D), the Pirate Cove (Emsian) and the underlying La Garde Formation unconformably overlie the Lower Devonian Dalhousie Group (Alcock, 1935; Dineley and Williams, 1968a, b) bracketing the first phase of deformation within Siegenian time. The information available from the Chaleur Bay

area may be open to some degree of interpretation (Breiner, personal communication, 1974), but the minimum age of the intense deformation cannot be younger than Lower Devonian. Two unconformities probably representing weaker phases of Acadian deformation occur (Table 1) in the Middle and Late Devonian (Boucot et al., 1964; Poole et al., 1970; Rodgers, 1970).

Maximum ages for the onset of the deformation can be determined from the palaeontologically well-dated and deformed strata (Table 1) at Cabano-Témiscouata (Fig. 2E), Rimouski-Matapedia, and Eastern Gaspé. None of these sections is overlain unconformably by undeformed rocks. In the Cabano-Témiscouata area, Lespérance and Greiner (1969) found that the Touladi Limestone and overlying Témiscouata Formation lie with disconformity or slight angular unconformity on the Late Silurian Mt. Wissick Group. Collections of corals from the Touladi Limestone dated by Boucot (1968) as Eifelian age are not reported in Lespérance and Greiner (1969), who state the age as Becraft-Oriskany (Siegenian). Carrara and Fyson (1973) have shown that only one deformation has folded and cleaved the Silurian and Devonian strata.

Eastward in the valley of the Matapedia River and south of Rimouski, the Lake Branch Formation overlies the Emsian to Eifelian age York River Formation (Béland, 1960). On the eastern end of the Gaspé Peninsula, the youngest folded unit is the Eifelian to Givetian aged Malbaie Formation (McGerrigle, 1950; Poole et al., 1970). Recent investigations of spore assemblages in the underlying Battery Point Formation by McGregor (1973) allow the Emsian-Eifelian boundary to be placed within the Formation. Overlying the succession with angular unconformity is the undeformed Cannes-des-Roches Formation of Namurian age (Poole et al., 1970).

Conclusions

Figure 3 illustrates that the intense phase of the Acadian deformation is oldest in the southern part of the map area and appears to become progressively younger northwards. The numerous concordant radiometric ages obtained from the Eastport area firmly define a Gedinnian-Siegenian age for the deformation there. The Rb-Sr whole-rock date on the Katahdin Batholith (395 my) is in contradiction with the palaeostratigraphic data and the Rb-Sr date on the Traveler Rhyolite (353 my, Naylor et al., 1974). In view of the few radiometric determinations in this area, the authors place more weight on the Upper Siegenian to Emsian deformation age obtained palaeostratigraphically. The sections (4, 6, 7 and 8; Table 1) in which the deformation is not stratigraphically bracketed are interpreted to have been affected by Acadian deformation because no evidence of a younger folding event has been recorded in Maine, central and northern New Brunswick, or adjacent Québec. Therefore, the age of deformation shown in the northern part in Figure 3 is post-Eifelian, and is significantly younger than the Gedinnian to Emsian age of deformation established to the south.

The evidence that the intense deformation was time-transgressive allows extension of the definition (by present usage) of the Acadian orogen to include deformation events in Lower Devonian tim Although deformation is only one of the many effect of an orogeny, the authors believe that further effort to refine the age of the onset of deformatio will provide a meaningful datum to which the age of metamorphism and the character of the pre- and post-orogenic rocks can be referred.

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