

Comment and Reply on 'Eolian dune field of Late Triassic age, Fundy Basin, Nova Scotia'

COMMENT

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Hubert and Mertz's (1980) description of newly discovered eolian dune sands in the lower Mesozoic Fundy Group of Nova Scotia provides the first definitive evidence of true aridity in the Newark Supergroup. According to Hubert and Mertz, the dune

sands occur in the Wolfville Formation and are Late Triassic in age (Figs. 1A and 1B). Hubert and Mertz suggested a regional south-to-north trend of increasing aridity during the deposition of the Upper Triassic part of the Newark Supergroup. I agree with their interpretation of the Red Head and Clark Head localities as eolian dune fields, but I suggest that the localities represent two horizons of different ages; Red Head is Late Triassic but Clark Head is Early Jurassic. This stratigraphic revision is crucial to the climatic framework for the whole of the Newark

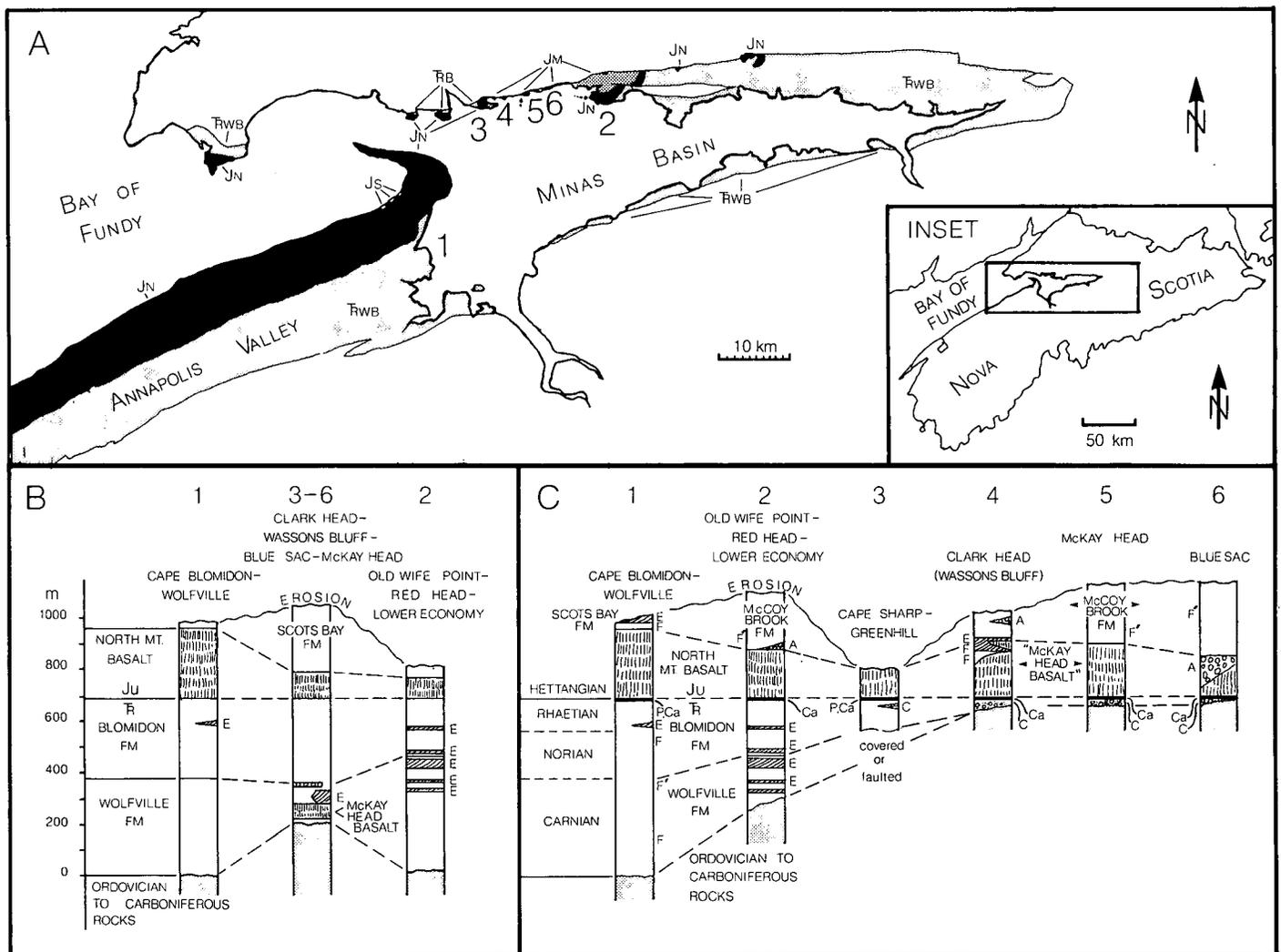


Figure 1. Diagrams of relationships of North Mountain Basalt to McKay Head Basalt of Klein (1962) and Wolfville, Blomidon, and Scots Bay Formations. Note that both position of Triassic-Jurassic boundary and stage boundaries are approximate; lowermost North Mountain Basalt could be latest Triassic age. Note also that relative positions of sections in C are not based on localities' geographic position, but rather on their position relative to north edge of basin. A straight-line series of sections is impossible because relevant exposures do not exist. A. Minas Basin part of Fundy Group, showing major lithostratigraphic divisions used in text. RWB = Late Triassic Wolfville and Blomidon Formations; RB = Late Triassic Blomidon Formation; JN = Early Jurassic North Mountain Basalt; JM = Early Jurassic McCoy Brook Formation; JS = Early Jurassic Scots Bay Formation; 1-6 = positions of sections in B and C. B. Stratigraphy of Minas Basin part of Fundy Group according to Hubert and Mertz (1980; modified from their Fig. 1). E = eolian sands discussed in text. Positions 1-6 as in A. C. Revised stratigraphy of Minas Basin part of Fundy Group. E = eolian sands; F = fossil-bearing horizons (reptile and amphibian bones, reptile footprints, and fossil fish); F' = horizon producing footprints discussed in text and listed in Figure 2; P = pollen-bearing horizons; Ca = carbonaceous horizon; C = varicolored conglomerate of upper Blomidon Formation. Positions of sections 1-6 as in A.

Supergroup, for it suggests that Hubert and Mertz's "arid to the north" trend was a prominent feature of not just Late Triassic time but the Early Jurassic as well.

Central to my argument are the stratigraphic position and age of the extrusive basalt flows that underlie and are interbedded with the dune sands at Clark Head (loc. 4 in Fig. 1A). Klein (1960, 1962) grouped this section of basalt flows with other similar outcrops along the north shore of the Minas Basin in his McKay Head Basalt. Klein (1960, 1962) concluded that this basalt flow formation occupies the boundary between the Wolfville and Blomidon Formations; the age of the McKay Head Basalt would thus be mid-Late Triassic by lithostratigraphic correlation with the type sections of the Wolfville and Blomidon Formations on the south shore of the Minas Basin (locs. 1 and 3-6 in Fig. 1B; Baird and Take, 1959; Baird, 1972, 1976). Hubert and Mertz (1980) followed Klein's interpretation.

Vertebrate fossils (both bones and trackways) are surprisingly common in the beds of the McKay Head Basalt and in the eolian sands at Clark Head. These fossils provide the first evidence on which to base the ages of the sections in dispute (Fig. 2). Most useful for biostratigraphy are the well-preserved and abundant reptile trackways found above the type section of the McKay Basalt at McKay Head (col. 5 in Fig. 1C), as well as in the Blue Sac section (col. 6), the Old Wife Point section (col. 2), and the type sections of the Wolfville and Blomidon Formations (col. 1). The footprint taxa are listed in Figure 2 with their ranges and localities. The footprint assemblage from the beds above the McKay Head Basalt is identical to "Connecticut Valley"-type assemblages from the more southern Newark Supergroup basins, and thus it indicates an Early Jurassic age for these beds (Olsen and Galton, 1977; Olsen, 1980; Olsen and others, 1981). Footprint assemblages from the boundary between the type sections of the Wolfville and Blomidon Formations on the south shore of the Minas Basin are completely different from those above the McKay Head Basalt, and they indicate a Late Triassic age (Baird, 1976). This latter age assignment is in line with all other biostratigraphic data (pollen and spore assemblages and vertebrate bones) from the Wolfville and Blomidon Formations (Olsen and others, 1981; Baird and Take, 1959; Baird, 1972; B. Cornet, personal commun.; J. Bujak, personal commun.). The age of the beds directly above the McKay Head Basalt thus appears to be Early Jurassic; this is incompatible

with correlation of the McKay Head Basalt with the type boundary between the Wolfville and Blomidon Formations, as suggested by Klein (1962) and Hubert and Mertz (1980).

The Clark Head locality itself (col. 4 in Fig. 1C) has produced a suite of reptile remains in the eolian sandstones and fish and reptile remains in the underlying green and gray siltstones. Unfortunately, none of the taxa indicate a more precise age than late Norian through Early Jurassic.

Because the fossils at Clark Head are not useful for detailed correlation, I suggest that the relative age of the dune sands can be determined by detailed lithostratigraphic correlation with the Cape Sharp, McKay Head, and Blue Sac sections (cols. 3, 5, and 6 in Fig. 1C). Howard V. Donohoe, Jr. and I have mapped a carbonaceous horizon (Ca in Fig. 1C) immediately under the basalt at several sections (cols. 1, 2, 3, 4, 5, and 6 in Fig. 1C), as well as a distinctive purple, light gray, and red conglomerate and sandstone containing clasts of the underlying Carboniferous strata (cols. 3, 4, 5, and 6 in Fig. 1C). At the Clark Head, McKay Head, and Blue Sac sections (Fig. 1C), there is a greatly reduced thickness (≤ 12 m) of strata under the basalt and unconformably overlying Carboniferous strata. The varicolored conglomerate and carbonaceous horizons are marker beds not found elsewhere in the exposed Fundy Group strata except immediately under the basalt. At Cape Blomidon, Old Wife Point, and Cape Sharp (Fig. 1C), the overlying basalt is undisputed North Mountain Basalt. This basalt either straddles the Triassic boundary or is wholly Early Jurassic. K-Ar dates from the North Mountain Basalt from the North Mountain region range from 195 ± 4 m.y. (ash bed at base of basalt; Armstrong and Besancon, 1970) to 200 ± 10 m.y. (average of five basalt samples; Carmichael and Palmer, 1968); the Triassic-Jurassic boundary has most recently been placed at 203 m.y. (R. L. Armstrong, 1981, and personal commun.). (These dates are 200 ± 4 , 205 ± 10 , and 208 m.y., respectively, if the new K constant is used.) I suggest that the McKay Head Basalt of Klein (1960, 1962) at Clark Head, McKay Head, and Blue Sac (Fig. 1C) is not an isolated unit of Late Triassic age but rather is a continuation of the North Mountain Basalt of Early Jurassic age. This conclusion is corroborated by the paleontological data shown in Figure 2. I further conclude that the eolian sands at Clark Head are Early Jurassic in age, and I therefore follow the stratigraphic terminology of H. V. Donohoe, Jr. and P. I. Wallace (in prep.) and

Figure 2. Footprint taxa from Minas Basin area of Fundy Group, showing their known stratigraphic range and locality at which they were found. Stratigraphic interval in which footprints were found at each locality is indicated by F' in Figure 1C. Age range in southern Newark Basins is based on Olsen (1980) and Olsen and Galton (1977). Detailed locality data given in Olsen and others (1981).

Footprint Taxon	AGE RANGE IN SOUTHERN NEWARK SUPERGROUP BASINS		Location			
	Late Triassic		McKay Head	Blue Sac	Old Wife Point	Cape Blomidon
	NORIAN	RHAETIAN				
Anomoepus spp.			X	X	?	
Olozoum sp.			X	X		
Eubrontes (Grallator) giganteus			X	X	X	
Batrachopus spp.			X	X	X	
Anchisauripus (Grallator) sillimani			X	X	X	
Anchisauripus (Grallator) hitchcocki			X	X	X	
Grallator cursorius			X	X	X	
Rhynchosauroides cf. R. brunswicki						X
"Anchisauripus" (new genus) mitfordensis						X

Keppie (1979) and use the term "McCoy Brook Formation" for both the red beds above the basalt and the Clark Head sands (Fig. 1C). The name "McKay Head Basalt" is no longer applicable.

Cornet (1977) has proposed an Early Jurassic "arid to the north" trend for the Newark Supergroup on the basis of floral data from basins south of the Fundy Group. Coupled with our stratigraphic reorganization, these interpretations augment Hubert and Mertz's broad climatic conclusions by showing that their sedimentologically based "arid to the north trend" applies to the Early Jurassic as well as the Late Triassic.

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REPLY

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We favor Olsen's idea that the fault-bounded outcrops named the McKay Head Basalt by Klein (1960, 1962) may be outcrops of North Mountain Basalt, removing the need for the McKay Head Basalt as a stratigraphic unit. Particularly significant is Olsen's discovery of the Jurassic reptile footprint taxa *Anomoepus* spp., *Otozoum* sp., and *Eubrontes giganteus* in the red beds overlying the McKay Head Basalt at McKay Head. The validity of Olsen's proposed correlation could be definitively established as more data become available. Especially needed are data on additional occurrences of both reptile footprints and pollen-bearing horizons, geochemical, petrographic, and paleomagnetic studies of the North Mountain and McKay Head Basalts, measured sections of these basalts, and detailed study of the structural geology of the area.

If the McKay Head Basalt is the North Mountain Basalt, then the eolian dune sandstones described by us (Hubert and Mertz, 1980) accumulated in the Fundy rift valley at various times during the Late Triassic and Early Jurassic, rather than just in the Late Triassic. The regional trend of increasing aridity from south to north along the chain of basins of the Newark Supergroup characterized both Late Triassic and Early Jurassic time.

COMBINED REFERENCES CITED

- Armstrong, R. L., 1981, Late Triassic-Early Jurassic time scale calibration in British Columbia, Canada, in Odin, G. S., ed., Numerical dating of stratigraphic column: (in press).
- Armstrong, R. L., and Besancon, J., 1970, A Triassic time scale dilemma: K-Ar dating of Upper Triassic mafic igneous rocks, eastern U.S.A. and Canada and post-Triassic plutons, western Idaho, U.S.A.: *Ecologiae Geologicae Helvetiae*, v. 63, p. 15-28.
- Baird, D., 1972, Burntcoat, Upper Triassic, in Carroll, R. L., Belt, E. S., Dineley, D. L., Baird, D., and McGregor, D. C., Vertebrate paleontology of eastern Canada: International Geological Congress, 24th Montreal, Excursion A59, p. 22-30.
- , 1976, Dinosaur footprints . . . in Nova Scotia: *Ichnology Newsletter*, v. 9 (1975-1976), no. 5.
- Baird, D., and Take, W., 1959, Triassic reptiles from Nova Scotia [abs.]: *Geological Society of America Bulletin*, v. 70, p. 1565-1566.
- Carmichael, C. M., and Palmer, H. C., 1968, Paleomagnetism of the Late Triassic, North Mountain Basalt of Nova Scotia: *Journal of Geophysical Research*, v. 73, p. 2811-2822.
- Cornet, B., 1977, The palynostratigraphy and age of the Newark Supergroup [Ph.D. thesis]: University Park, Pennsylvania State University, 506 p.
- Hubert, J. F., and Mertz, K. A., 1980, Eolian dune field of Late Triassic age, Fundy Basin, Nova Scotia: *Geology*, v. 8, p. 516-519.
- Keppie, D., compiler, 1979, Geologic map of Nova Scotia: Nova Scotia Department of Mines and Energy.
- Klein, G. deV., 1960, Stratigraphy, sedimentary petrology, and structure of Triassic sedimentary rocks, Maritime Provinces, Canada [Ph.D. thesis]: New Haven, Conn., Yale University, 262 p.
- , 1962, Triassic sedimentation, Maritime Provinces, Canada: *Geological Society of America Bulletin*, v. 73, p. 1127-1146.
- Olsen, P. E., 1980, A comparison of the vertebrate assemblages from the Newark and Hartford basins (Early Mesozoic, Newark Supergroup) of eastern North America, in Jacobs, L. L., ed., *Aspects of vertebrate history: Flagstaff*, Museum of Northern Arizona Press, p. 35-53.
- Olsen, P. E., and Galton, P. M., 1977, Triassic-Jurassic tetrapod extinctions: Are they real?: *Science*, v. 197, p. 983-986.
- Olsen, P. E., McCune, A. R., and Thomson, K. S., 1981, Correlation of the early Mesozoic Newark Supergroup by vertebrates, principally fishes: *American Journal of Science* (in press).