Cassiar platform, north-central British Columbia: A miogeoclinal fragment from Idaho

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ABSTRACT

The allochthonous Cassiar platform, in north-central British Columbia, is a cratonal fragment of ancestral North America juxtaposed against autochthonous North American crust along the Tintina–Northern Rocky Mountain trench fault. The Cassiar platform records a Neoproterozoic to early Paleozoic rift to passive-margin history that includes Lower Cambrian archeocyathan-bearing limestones of the Rosella Formation in the Cassiar Mountains. This study indicates that an extensive oolitic shoal developed toward the western edge of this carbonate platform during the deposition of the *Nevadella* zone, parallel to the western limit of thick continental crust (initial-Sr 0.706 isopleth). Paleogeographic studies from other archeocyathan-bearing units in the Cordillera indicate that a semicontinuous oolitic shoal was along the western margin of the continental shelf from Alaska to Mexico. There is a distinctive gap in the passive-margin record from southeastern Washington to southern Idaho. Paleogeographic constraints from the Rosella Formation and published paleomagnetic data from the overlying Sylvester allochthon suggest that this miogeoclinal slice was originally deposited near present-day Idaho and was transported northward, along poorly constrained dextral strike-slip faults.

INTRODUCTION

For much of its extent from northern Canada to southern California, the North American Cordillera contains a characteristic assemblage of Neoproterozoic to early Paleozoic rift to passive-margin sedimentary units (Stewart, 1991). Neoproterozoic Windermere Supergroup rift facies and equivalents overlap truncated Archean and Paleoproterozoic crystalline rocks or Mesoproterozoic sedimentary basins (Stewart, 1972; Ross, 1991). The Windermere diamictites, greenstones, dolomites, and immature turbidites are unconformably overlain by Neoproterozoic–Lower Cambrian quartzarenites deposited during rifting and continental separation between 600 and 550 Ma (Bond and Kominz, 1984). The quartzarenite is conformably overlain by Lower Cambrian (upper Atdabanian–lower Botomian) archeocyathan-bearing limestones that mark the initiation of passive-margin sedimentation. Lower Cambrian limestone extends from Alaska to northeastern Washington (Fig. 1A) and is present from southern Idaho to Nevada, and into eastern California and northern Mexico (Stewart and Suczek, 1977; Stelck and Hedinger, 1975; Fritz et al., 1992). The western edge of this carbonate platform roughly parallels the initial $^{87}Sr/^{86}Sr$ 0.706 isopleth, which is interpreted to mark the approximate rifted limit of thick North American crust, where shallow-water shelf deposits passed westward into deposits of the continental slope and rise (Sears and Price, 1978; Levy and Christie-Blick, 1989).

MISSING MIOGEOCLINE

There is 400 km gap in the distinctive Neoproterozoic to early Paleozoic assemblage between northeastern Washington and southern Idaho (Burchfiel et al., 1992). Accreted terranes (Wallowa and Seven Devils) abut Mesoproterozoic sedimentary rocks of the Belt Supergroup along the Western Idaho suture zone (Hyndman et al., 1988; Strayer et al., 1989). Because the deposits of intraplate continental margins develop in response to continental separation and subsequent thermally driven subsidence (Devlin and Bond, 1988), it is unlikely that a 400 km segment of the North American continental margin would receive no sediments for several hundred million years. In addition evidence for Neoproterozoic–early Paleozoic, westward-thickening, predominantly siliciclastic miogeoclinal sedimentation in central and southern Idaho (Oriel and Armstrong, 1971; Peterson, 1988) indicates that miogeoclinal deposition occurred outboard of central and southern Idaho and was later structurally truncated (Burchfiel et al., 1992). Truncation of the continental margin would postdate early Paleozoic sedimentation and predate final suturing of the Wallowa and Seven Devils terranes in the Cretaceous (Lund and Snee, 1988).

The Cassiar platform (Cassiar and neighboring Pelly Mountains) straddles the British Columbia–Yukon Territory border (Fig. 1A), 1800 km

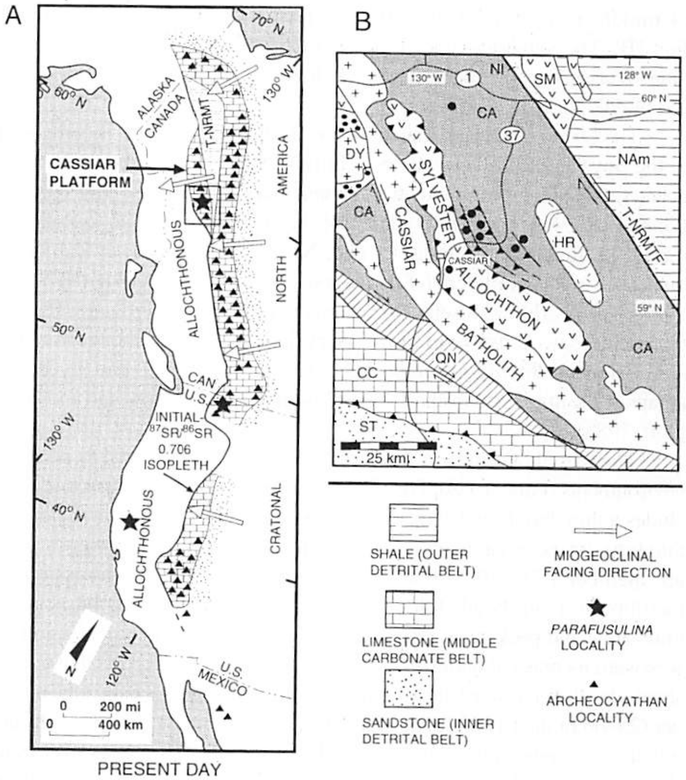

Figure 1. A: Map of present-day western North America showing position of allochthonous Cassiar platform. Lower Cambrian depositional belts (inner detrital, middle carbonate, and outer detrital) are adapted from Robison (1960). Archeocyathan localities are from Stelck and Hedinger (1975) and Stewart and Suczek (1977). Permian (Guadalupian) giant *Parafusilina* localities are from Butler et al. (1988, and references therein). Initial-Sr 0.706 isopleth is adapted from Armstrong et al. (1977) and Armstrong (1988). White arrows indicate direction in which Early Cambrian miogeoclinal rocks thicken. Box shows approximate location of part B. B: Generalized map of Cassiar platform (McDame map area) near British Columbia and Yukon Territories boundary (adapted from Gabrielse, 1963; Richards et al., 1993). Locations of measured sections used in this study are shown by black dots. Abbreviations of terranes and other pertinent features: SM—Slide Mountain, CA—Cassiar Platform, HR—Horseranch Range metamorphic core complex, NI—Nisling, DY—Dorsey, QN—Quesnellia, CC—Cache Creek, ST—Stikinia; T-NRMTF—Tintina–Northern Rocky Mountain trench fault, and NAm—North America.

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to the northwest of the miogeoclinal gap. This allochthonous continental crustal fragment, bounded by strike-slip faults, represents a structural repetition of Neoproterozoic to early Paleozoic rift and passive-margin sedimentary rocks in this area (Tempelman-Kluit, 1979). Estimates of the displacement of this platform along the Tintina–Northern Rocky Mountain trench fault system and other poorly defined dextral strike-slip faults range from 450 km (Tempelman-Kluit, 1979) to greater than 1000 km (Gabrielse, 1985, 1991). The Cassiar platform was tectonically stretched during part of its northward translation and had an original length comparable to the miogeoclinal gap. We suggest that the Cassiar platform may have been derived from the miogeoclinal gap, severed during late Paleozoic–Mesozoic orogenesis of the Cordillera, and transported northward to its present location.

CASSIAR PLATFORM STRATIGRAPHY AND PALEOMAGNETIC CONSTRAINTS

The Cassiar platform in the McDame map area (Cassiar Mountains) contains Neoproterozoic Windermere Supergroup equivalents (Ingenika Group) unconformably overlain by Neoproterozoic–Lower Cambrian quartzarenites and archeocyathan-bearing limestones (Mansy and Gabrielse, 1978; Fritz, 1978). This succession records a geologic history similar to that of southern British Columbia and southern Idaho, including evidence of middle Paleozoic "Antler-style" deformation (Gordey et al., 1987; Fig. 1B). The Sylvester allochthon, a complex assemblage of Upper Devonian–Triassic oceanic rocks, was likely accreted to the Cassiar platform by the Middle Jurassic (Gabrielse, 1991).

The Lower Cambrian Atan Group in the Cassiar platform is composed of the Boya and Rosella formations (Fritz, 1980). The Boya Formation is a coarse-grained sandstone and quartzite unit that grades upward into siltstone (Gabrielse, 1963; Fritz, 1978) and probably represents fluvial to shallow-marine sedimentation, similar to other Neoproterozoic–Lower Cambrian quartzites in the Cordillera (cf. Fedo and Cooper, 1990; Devlin and Bond, 1988). The overlying Rosella Formation is a richly fossiliferous succession that includes two siltstone to carbonate cycles containing trilobites from the *Nevadella* and *Bonnia-Olenellus* zones (Fritz, 1978, 1980) and archeocyathans of the upper Atdabanian–lower Botomian stages (Rowland and Gangloff, 1988).

The Rosella Formation was deposited in shallow subtidal to peritidal environments (Pope, 1989). The lower siltstone member (28–40 m thick) includes a thin, basal sandstone overlain by interbedded siltstone, shale, and thin limestone containing rare archeocyathan bioherms. The lower carbonate member (50–150 m thick) is a shallowing-upward succession of medium- to thick-bedded, locally cross-bedded, oolitic and intraclastic grainstone and packstone indicative of high-energy subtidal deposition. A westward increase of oolitic grainstone in this member suggests that oolitic shoals developed toward the shelf margin (Fig. 2). The upper siltstone member (25–60 m thick) is composed of siltstone, shale, and quartzite with carbonate interbeds, and records progradation of lagoonal facies over ooid shoals, probably during a sea-level fall. Upper carbonate rocks (87–250 m thick) include thick-bedded intraclastic and ooid grainstone with some pellet wackestone, indicating renewed transgression and deposition in a subtidal environment. The upper contact is not exposed because of subsequent thrusting.

Paleomagnetic data from the overlying Sylvester allochthon in the Cassiar area (Butler et al., 1988) indicates it has undergone 600 km of northward translation since 105 Ma. Furthermore, Richards et al. (1993) suggested that at least part of the Sylvester allochthon in this area has undergone 2000–2500 km (up to 20°) of northward translation, most of it during Permian and Triassic time.

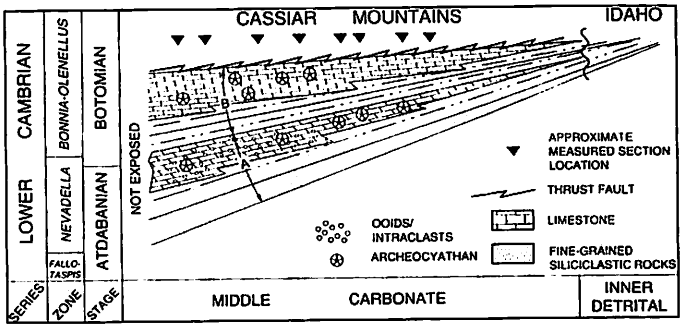

Figure 2. Schematic cross section of Lower Cambrian archeocyathan-bearing limestones and interbedded clastic rocks (adapted from Fritz, 1975). A and B correspond to grand cycles based on regional correlations. Inverted triangles above cross section approximate location of measured sections in this study. Rosella Formation of Cassiar platform is interpreted to correspond with carbonate-rich outboard portion of cross section, whereas siliciclastic-rich inner portion was stranded in Idaho (Oriel and Armstrong, 1971; McCandless, 1983). Basinal facies are not exposed.

REGIONAL CORRELATIONS

Lower Cambrian archeocyathan-bearing formations of late Atdabanian to early Botomian age extend discontinuously from Mexico to northern Nevada and from northeastern Washington to Alaska (Fig. 1A) and are grouped into three lithostratigraphic belts (inner detrital, middle carbonate, and outer detrital) that roughly paralleled the Cambrian shoreline (Robison, 1960). The inner detrital belt represents deposition in low- to moderate-energy sand- and mud-dominated environments landward of a carbonate bank, and the outer detrital belt represents deposition of black shale and siltstone seaward of the carbonate bank. Lower Cambrian archeocyathan-bearing formations in the Cordillera can generally be subdivided into three "grand cycles" (Fritz, 1975), each characterized by a shaly base and a carbonate cap (Fig. 2). The basal cycle (A) is composed of fine-grained siliciclastic rocks and thin carbonate interbeds that grade upward into an overlying carbonate member in the *Nevadella* zone. Archeocyathan bioherms are locally common in the carbonate interbeds in the siliciclastic intervals. The carbonate member contains abundant oolites, intraclasts, and archeocyathan bioherms. The lower siltstone and lower carbonate members of the Rosella Formation correspond to this basal cycle (Fig. 2).

The middle cycle (B) consists of a thin siliciclastic interval, the base of which is at, or near, the *Nevadella* and *Bonnia-Olenellus* zone boundary, and a conformably overlying thick carbonate member (Fritz, 1975; Fig. 2). The carbonate member is primarily a pisolitic and oncolitic grainstone with subordinate oolitic and intraclastic grainstone. The middle cycle (B) is represented in the Cassiars by the upper siltstone and limestone members of the Rosella Formation. The upper cycle (C) is not exposed in the study area, but is present in the southern Cassiars (Fritz, 1978).

The paleogeography of the basal unit (grand cycle A) in the Rosella Formation—an oolitic shoal complex to the west that passes eastward into a silty, quiet-water peritidal setting—is very similar to the paleogeography inferred for the basal carbonate member of Lower Cambrian limestones elsewhere in the Cordillera (cf. Moore, 1976; Rowland, 1981). The strong similarities of lithofacies between the Lower Cambrian limestones in the Cassiar platform and other localities in the Cordillera and the common appearance of oolitic limestone from California to Alaska suggest that oolitic shoals commonly developed toward the seaward edge of the carbonate shelf during the *Nevadella* zone (Fig. 3).

Geochronologic studies that propose shortening the Cambrian System by ~30 m.y. (e.g., Bowring et al., 1993) and the suggestion by Landing (1994) that the majority of Early Cambrian time may be pretrilobitic suggest that archeocyathan stages are on the order of 1–5 m.y. duration. Thus, these archeocyathan limestones constitute a well-defined stratigraphic marker unit that may be useful for regional tectonostratigraphic correlation. Each siliciclastic-carbonate couplet (grand cycles A, B, and C) is probably a third-order (1–3 m.y. duration) depositional sequence, the siliciclastic strata representing lowstand deposits and the carbonate strata representing

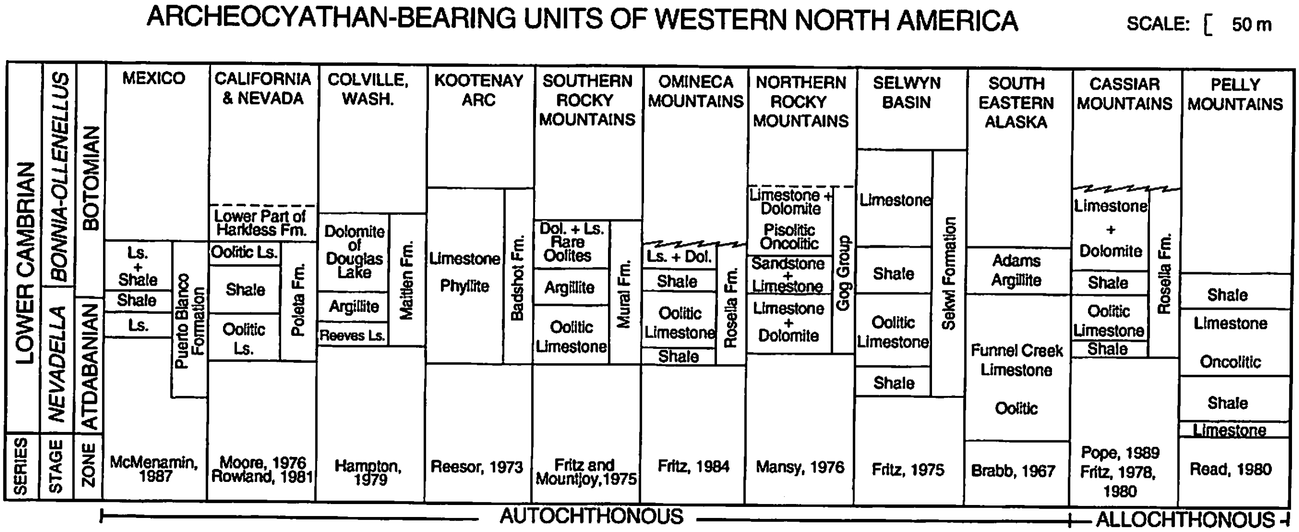

Figure 3. Correlation chart of Archeocyathan-bearing limestones in North American Cordillera. Note near time equivalence of each Lower Cambrian limestone unit. Datum is *Nevadella–Bonnia-Olenellus* zone boundary.

transgressive and highstand deposits. The bands of *Nevadella* archeocyathan bioherms are thus narrow paleogeographic markers of extremely short duration, representing time lines and map lines, duplicated in northern British Columbia, and missing in western Idaho.

DISCUSSION

The allochthonous Cassiar platform contains a section of Lower Cambrian peritidal and shallow-shelf limestones and siliciclastic rocks that is tectonically stranded along the Tintina–Northern Rocky Mountain trench fault against Lower Cambrian basinal shales of the Mackenzie Mountains (Fig. 1A). Restoring the Cassiar platform 600 km southward (Fig. 4) in accordance with paleomagnetic data of Butler et al. (1988) juxtaposes two westward-facing packages of Lower Cambrian passive-margin sedimentary rocks. We propose that the platform restores to the severed Idaho to southeastern Washington segment of the passive margin (Fig. 4), in accord with paleomagnetic constraints from Richards et al. (1993).

The proposed reconstruction would (1) result in a passive margin with a nearly continuous ooid-archeocyathan shoal from Alaska to Mexico during the brief *Nevadella* zone; (2) restore the archeocyathan migration pathway proposed for western North America (Rowland and Gangloff, 1988); (3) place Permian fusulinid-bearing limestones of the Sylvester allochthon (used in paleomagnetic studies by Butler et al., 1988) nearer to the other two locations of these fossils, in allochthonous blocks of northeastern Washington and northern California, possibly indicating that all three localities are part of the same tectonic domain; and (4) restore the initial $^{87}Sr/^{86}Sr$ 0.706 isopleth to a single smooth trace in this area, more representative of a passive margin.

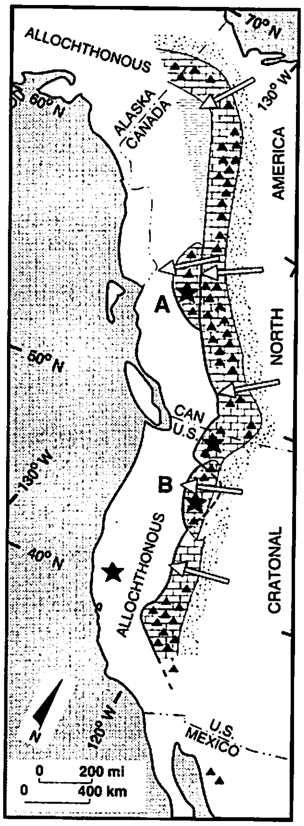

Figure 4. Map of U.S. Cordillera with Cassiar platform translated 600 km south (A) in accordance with paleomagnetic data from Butler et al. (1988) and to its proposed site of deposition (B) in accord with subsequent >2000 km northward translation (Richards et al., 1993). Cassiar platform is smaller (~400 km) than in Figure 1A because subsequent strike-slip lengthening was restored. Symbols are the same as in Figure 1A.

CONCLUSIONS

On the basis of stratigraphic information presented here and previous paleomagnetic data, the Cassiar platform in north-central British Columbia is interpreted to represent an allochthonous passive-margin section that was originally deposited near Idaho. This fragment was severed from North America and translated northward along the Tintina–Northern Rocky Mountain trench fault and other poorly defined dextral strike-slip faults that roughly parallel the initial $^{87}Sr/^{86}Sr$ 0.706 isopleth to its present location.

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