Lithostratigraphy and depositional setting of the limestone-rich interval of the Lahood Formation (Belt Supergroup), southwestern Montana
by Adrienne Thornley Bonnet

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Earth Sciences
Montana State University

Abstract:
The LaHood Formation crops out along a narrow east-west trending belt which coincides with the Willow Creek fault zone. This 3500 m thick arkose and arkosic conglomerate deposit contains a distinctive 400 m thick limestone-rich interval near the top. The limestone-rich interval crops out in the Horseshoe Hills and Bridger Range and is similar to intervals in various stratigraphic positions in the formation of other areas.

The limestone-rich interval of the LaHood Formation contains two types of depositional sequences which alternate and reflect mass flow and suspension deposition in relatively deep water. The arkose depositional sequences contain 25 m of undeformed arkose beds which range between 1 m and 5 m thick. The limestone-bearing depositional sequences are 30 m thick and contain both rhythmically and randomly interbedded limestone, siltstone, shale, and arkose in addition to intraformational slump structures.

The arkose depositional sequences are interpreted as channel deposits of the lower-upper fan and middle fan of a submarine fan system. Arkose beds in these sequences are amalgamated, and contain rip-up and floating clasts of silt-stone, shale, and limestone; both normal and inverse graded bedding; and basal conglomerates. The limestone-bearing depositional sequences represent interchannel deposits of a submarine fan system. Small scale deformation features and their distribution in slump structures reflect opencast slump processes and include: plastically deformed septarian concretions, molar tooth structures, imbricate thrusts, and truncated decollement folds. The deformation reflects both faulting and bank undercutting by migrating distributary channels.

The LaHood Formation geometry, lithologies, and association with fault zones which were probably active during the Precambrian together suggest fault-controlled deposition. The east-west fault zone may be related to the origin of the Belt basin as an abandoned rift arm or a transform fault zone. Northwest-southeast trending faults to the south of this zone may be secondary shear faults formed during transform movement and may also have influenced LaHood Formation deposition.

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Date 13 November 1979

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ABSTRACT

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INTRODUCTION

The LaHood Formation of the Belt Supergroup (Precambrian Y) in southwestern Montana is a 3500 m thick wedge of arkose and arkosic conglomerate which contains a 400 m thick limestone-rich interval near the top. The limestone-rich interval studied in the Horseshoe Hills and Bridger Range consists of two types of depositional sequences which alternate and may reflect lower-upper fan and middle submarine fan processes and episodic faulting along the southern margin of the Belt embayment.

The LaHood Formation has been studied across the 130 km outcrop extent in varying detail. The studies in the limestone-rich interval of the formation involved details of deformation structures and characteristics related to the formation as a whole, such as thickness and stratigraphic position.

Peale (1893) and Walcott (1899) described general characteristics of the coarse Belt rocks, including those in the limestone-rich interval, and recognized them as nearshore equivalents of the finer-grained Belt rocks to the north. In order to map the structure in the Whitehall area, Alexander (1955) measured and correlated sections,

described the type section near LaHood Park, and described the petrography of rocks in that area. Verrall (1955) described some lithologic features of the limestone-rich interval and mapped the distribution of outcrops as part of a larger mapping project in the Horseshoe Hills. McMannis (1963) was the first to measure sections of the formation throughout the extent of outcrops and describe the stratigraphy and lithology by area. In addition to defining the formation and indicating a principal reference section, McMannis (1963) referred to a limestone-rich interval, first recognized by Verrall (1955), as the "'molar tooth' and algal zone". McMannis (1963) stated that this zone is the "only reasonable key horizon" and used it to correlate sections in the Bridger Range and Horseshoe Hills with each other and with other Belt rocks to the north. In an abstract, Hawley (1973) described characteristics of the formation and proposed that turbidity currents, sand flows, and submarine slides deposited sediment in a fault-bound basin adjacent to a rugged Precambrian crystalline source area. The only other reference to this limestone-rich interval was made by Hawley and Schmidt (1974) in a field guide. In order to propose a depositional system for the formation, Boyce (1975) measured sections

throughout the extent of the outcrops and defined vertical and lateral facies changes, stratigraphic relationships to other Belt rocks, and petrographic trends. Although McMannis (1963) and Hawley (1973) interpreted some of the paleogeographic conditions during deposition of the formation, Boyce (1975) was the first to design a detailed study with the intention of interpreting the environment of deposition. Trunk and Smith (1979) studied details of the molar tooth structures in the southern Horseshoe Hills and concluded these structures represent soft sediment deformation of cryptalgal laminites.

Sections were measured by the author in the Horseshoe Hills and Bridger Range limestone-rich interval in order to describe details of the stratigraphy and lithology and propose a sedimentary-tectonic environment of deposition. This paper attempts to show that (1) this interval may reflect processes and environmental conditions which were present throughout LaHood Formation deposition, (2) the two types of alternating depositional sequences represent channel and interchannel deposits on the lower-upper fan and middle fan segments of a submarine fan system, and (3) the deposits may also reflect episodic faulting along the southern margin of the Belt embayment.

GEOLOGIC SETTING

Location

The limestone-rich interval of the LaHood Formation crops out in southwestern Montana north of the East Gallatin River in the Horseshoe Hills and in Felix Canyon on the west side of the Bridger Range (Fig. 1). Similar intervals crop out in the Highland Mountains (Thorson, J., 1979, oral commun.) and near St. Paul Gulch, north of Whitehall (Coppinger, W., 1979, oral and written commun.). The nearly continuous exposures along 6 km of the East Gallatin River in the Horseshoe Hills provide an opportunity to observe detailed lithologic and stratigraphic characteristics of the limestone-rich interval with little structural complication. The interval is well exposed in Felix Canyon; however, the geometry of the steeply dipping beds is difficult to discern in logging road cuts.

Modern Setting

The upper LaHood Formation crops out in a series of bevelled Laramide folds which plunge to the north in the Horseshoe Hills. Some faults with minor displacements cut the formation near the contact with the Cambrian Flathead Formation, but do not cut LaHood exposures along the East Gallatin River (Verrall, 1955).

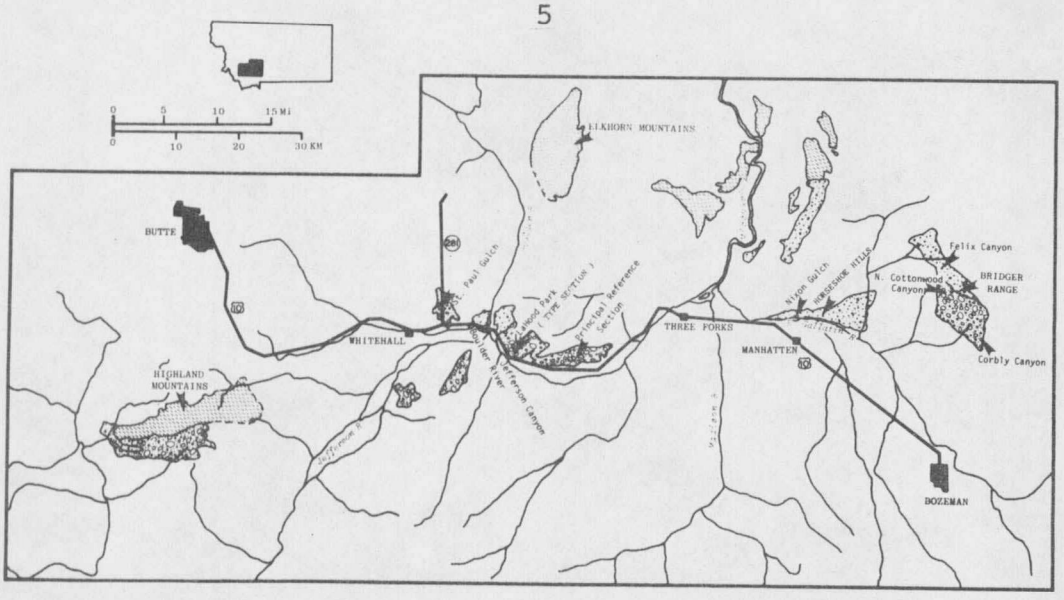

FIGURE 1a. Distribution of known LaHood Formation outcrops and locations of stratigraphic sections referred to in text under the heading Lithostratigraphy. Author's measured sections lie along the East Gallatin River in the southern Horseshoe Hills and in Felix Canyon, the Bridger Range. Modified from McMannis (1963).

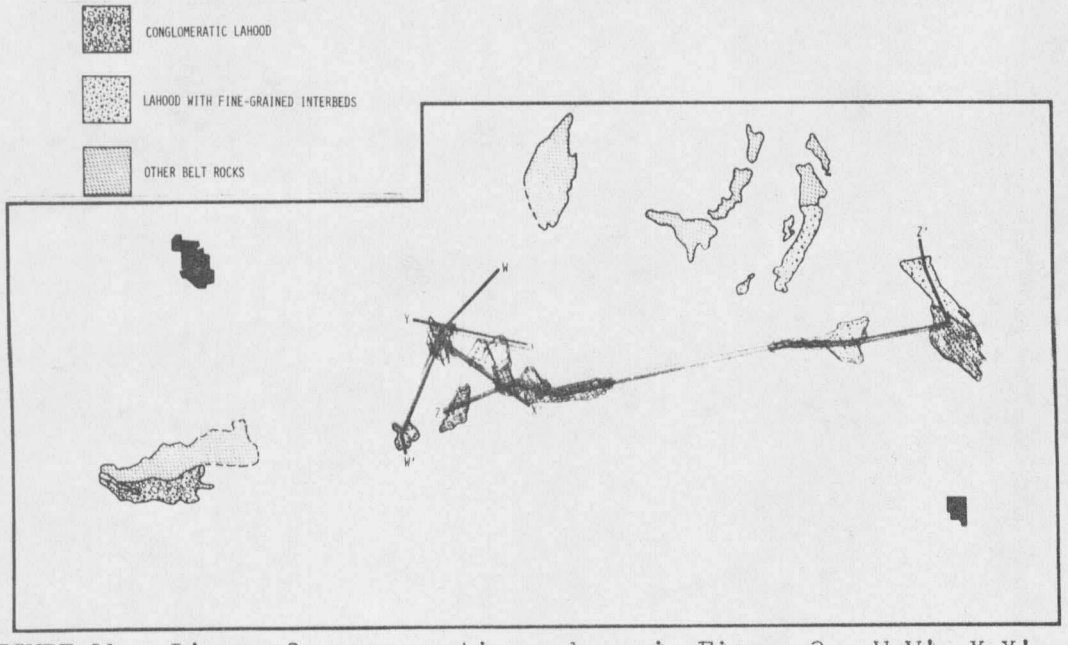

FIGURE 1b. Lines of cross sections shown in Figure 3. W-W', Y-Y', and Z-Z' modified from McMannis (1963); X-X' modified from Alexander (1955).