A STUDY OF LIMESTONE COBBLES FROM THE MORRISON (?) FORMATION OF CENTRAL UTAH

Senior Thesis

Presented in Partial Fulfillment of the Requirements for the Degree Bachelor of Science

by

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1977

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INTRODUCTION

Limestone cobbles from the lower Morrison (?) Formation in Sanpete Valley of central Utah contain an endothyroid foraminiferal fauna indicating a probable source area of Mississippian limestone. The conglomerate also contains well-rounded quartzite cobbles and boulders derived from upper Precambrian and Cambrian rocks to the west. The presence of these limestone cobbles and the large size of the quartzite clasts suggests short transport from a nearby source area of high relief. The preservation of the limestone clasts may also be accounted for by arid climatic conditions.

The conglomerates of the Morrison (?) Formation in Sanpete Valley represent the oldest of the fanglomerates from the Sevier orogenic belt which was active from Late Jurassic (?) to Early Tertiary times. The source area for these fanglomerates was probably the upper plate of a large overthrust such as the Canyon Range and Pavant Range thrusts. The Wah Wah, Frisco, Ogden-Taylor, Willard, Nebo-Charleston, Sheeprock, Gas Peak, Glendale and Muddy Mountain thrusts are other examples of faults probably initiated during the early part of the Sevier orogeny. Miogeosynclinal Paleozoic sediments along with Cambrian and some Precambrian crystalline rocks were thrust over Mesozoic strata. The fanglomerates were left as the thrust plate was eroded back. Renewed thrusting produced another wedge of conglomerates in Late Cretaceous times.

STRUCTURAL AND STRATIGRAPHIC SETTING

Sevier Orogenic Belt

The Sevier orogenic belt extends from the southeastern corner of Nevada through western and central Utah and into Idaho (Figure 1). This belt is typified by large scale overthrust faults and compressional folds of Late Jurassic (?) through Early Tertiary age. The faults are of the décollement type, flattening out at depth in Eocambrian quartzite-shale sequences (Armstrong, 1968). Shale units provided the major zones of bedding-plane movement. Crustal shortening appears to be 25 to 35 km across the Sevier belt (Armstrong, 1968). Subsequent erosion of the upper thrust plates produced a thick clastic sequence deposited as alluvial conglomerates on a piedmont area east of the belt (Christiansen, 1952).

There are those who believe that the source of these clastic sediments shed to the east was a positive area in western Utah and southeastern Nevada. H.D. Harris (1959) named this positive area the Sevier arch. He believes that the thrusting postdated major folding in the area and occurred along belts of weakness produced by major folds. The thrusts such as those of the Pavant Range and Canyon Range

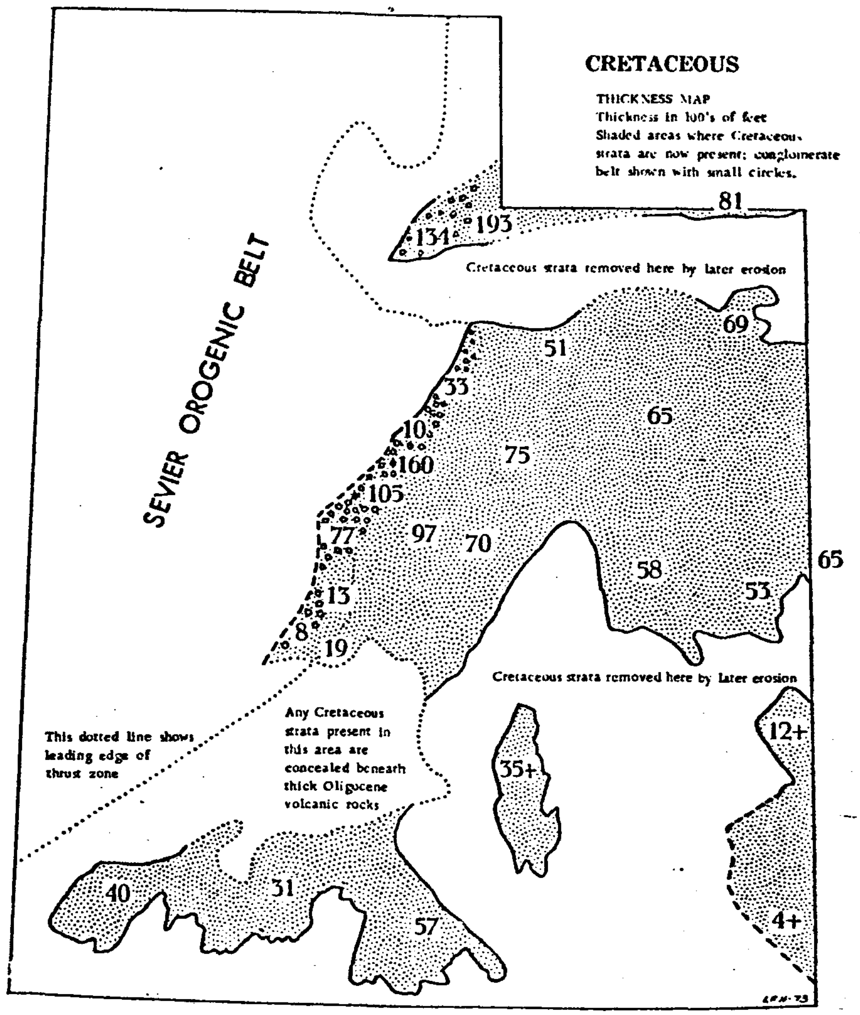

Figure 1. Cretaceous thickness map showing the thrust zone of the Sevier orogenic belt. (from Hintze, 1976).

were thought to be part of the Laramide orogeny in Late Cretaceous times.

These thrusts are now believed to be involved in the Sevier orogeny beginning in Late Jurassic (?) or Early Cretaceous times. Armstrong (1968) argues the bedding-plane thrusts cannot develop after an area has been folded and that thrusting was so prolonged and of such great magnitude that the effects could hardly be the result of simple arching. The Sevier belt may have begun as an arch (Armstrong, 1968), but thrusting with either contemporaneous or subsequent folding is more characteristic of orogenic activity in this area.

Different pulses of the Sevier orogeny were marked by the wedge-shaped tongues of fanglomerate along the eastern margin of the orogenic belt. Initial thrusting produced erodable highlands from which fanglomerates of Late Jurassic (?) age were derived. This first pulse is represented by the Morrison (?) Formation and its age equivalent rocks which possibly include basal Kelvin and Ephraim conglomerates (Stokes, Eardley, 1944). The Indianola, upper Kelvin, and Buckhorn conglomerates of the Cedar Mountain Group are Lower Cretaceous, and represent renewed thrusting in the Sevier belt(Christiansen, 1952).

The major problem in dating orogenic activity in the Sevier belt is that these units, which represent this activity, lack fossils and are lithologically similar. Correlating orogenic pulses with these conglomerates is extremely difficult. The

Morrison (?) Formation could be part of the basal Indianola Group which would assign it to an Early Cretaceous age as opposed to Late Jurassic (Spieker, 1946), (Eardley, 1944). The Buckhorn conglomerate is above the Morrison in sequence in a section of the northern San Rafael area. It is assigned an Early Cretaceous age by Stokes (1944). He describes the Buckhorn as a black chert conglomerate much like the Ephraim and lower Kelvin conglomerates in lithology. This suggests an Early Cretaceous age for the Ephraim and lower Kelvin Formations which have also been correlated with the Morrison (?) Formation of the Late Jurassic. Few fossils are found in any of these formations to substatiate a definite age assignment. Possibly, with an accurate solution to the age problem of the Morrison (?) Formation, correlation of the other conglomerates will be simplified. This would allow more accurate dating of orogenic activity in the Sevier belt.

The Morrison (?) Formation

The limestone clasts under study were taken from a section of the Morrison (?) Formation at the south end of the Gunnison Reservoir along the southeastern edge of the Gunnison Plateau in Sanpete Valley of central Utah. The thickness of the formation ranges from 700-900 m thick. Beds are mainly massive conglomerate with clasts ranging from two to 20 cm in diameter and composed of quartzite, limestone, sandstone, and mudstone. The matrix is commonly a poorly sorted, angular to subangular sandstone. At the top of the section, a widespread boulder bed is present containing subrounded quartzite boulders up to 1.5 m in diameter within a red mudstone matrix.

Beds in Salina Canyon and in a section east of Thistle, Utah are correlated stratigraphically and lithologically with the beds along the eastern edge of the Gunnison Plateau in Sanpete Valley. Spieker (1946) identified the Salina Canyon and Thistle beds as Morrison based on their stratigraphic position and lithologic character. No fossils have been found in these beds to assign them a definite age.

Above the Morrison (?) Formation, the conglomerates of the Sanpete Formation (Indianola Group) contain fossils of Coloradan age. The boundary between the Morrison (?) and the Sanpete Formation remains obscure since it is based solely on color change between the reds of the Morrison (?) Formation and buff and gray rocks of the Sanpete Formation (Spieker, 1946).

Since there are no fossils in the beds and the lithology can support either Morrison or Indianola origin, these beds in Salina Canyon, the Thistle area and Sanpete Valley have been assigned to the Morrison (?) Formation.

LITHOLOGY AND PALEONTOLOGY OF LIMESTONE CLASTS

The lithology and paleontology of limestone clasts in the Morrison (?) Formation ~~was~~ were determined through a laboratory probe for microfossils and a thin section study. The purpose was to determine the age of these conglomerate cobbles by the age assigned to the fossils they contain and to establish their source.

Fourteen crushed samples of limestone conglomerate cobbles collected from the Morrison (?) Formation in Sanpete Valley, designated JC 1 through JC 14, were dissolved in acetic acid and the residue was searched for microfossils. Only a few fragmental conodonts were found which were of little use in age determination. The presence of conodonts did establish the fact that the rocks are Middle to Late Paleozoic in age.

In two samples (JC 1 and JC 6), an abundance of fish teeth indicated a post-Ordovician age for the rock. Other abundant fossils included gastropod, crinoid, bryozoan and coral fragments and molds.

The cobbles are composed of dark gray, fossiliferous limestone with minor amounts of chert. The coarse fraction retained from dissolving one to two kg samples in acetic acid amounted to only a trace with most samples. One sample (JC 7) remained only partially dissolved suggesting that the rock was dolomitic.

In thin section analysis, eight were studied and classified representing the same sample limestone cobbles used in the microfossil probe. Most of the rocks could be classified as biosparites with a few dolomitic limestones (See Appendix 1). Faunal and lithologic similarities suggest that these samples are derived from the same formation.

The only fossils useful in determining the age of the limestone cobbles from thin section analysis were foraminifers found in several sections (Figure 2). The tests of these forams in thin section appear to be composed of a dark, finely granular material, suggesting a Late Paleozoic age (Henbest, 1960). Upon comparison of the foraminifera found in the thin sections with photographs of oriented sections (Skipp, 1969), (Woodland, 1968), the forams were identified as belonging to the family Endothyridae. Endothyroids were prevalent throughout Mississippian time and are abundant in nearly all of the rocks of that age in central and western Utah.

Woodland (1968) has placed the endothyroid foraminifera of Mississippian rocks in the Provo Rock Canyon area into three zones. The zone containing the genus Granuliferella, distinguished by a granular, single layered wall, is at the base. They are of Osagian age almost exclusively and are widespread in the upper Madison or Gardison Limestone of central Utah. Identification of the forams in the clasts of the Morrison (?) Formation is difficult since Woodland's photographs are of oriented endothyroid sections. At least a few of the endothyroids in the studied sections appear to be referable to the genus Granuliferella.

CONCLUSIONS AND SUMMARY

The endothyroid foraminiferal faunas found in the limestone cobbles of the Morrison (?) Formation indicate that these

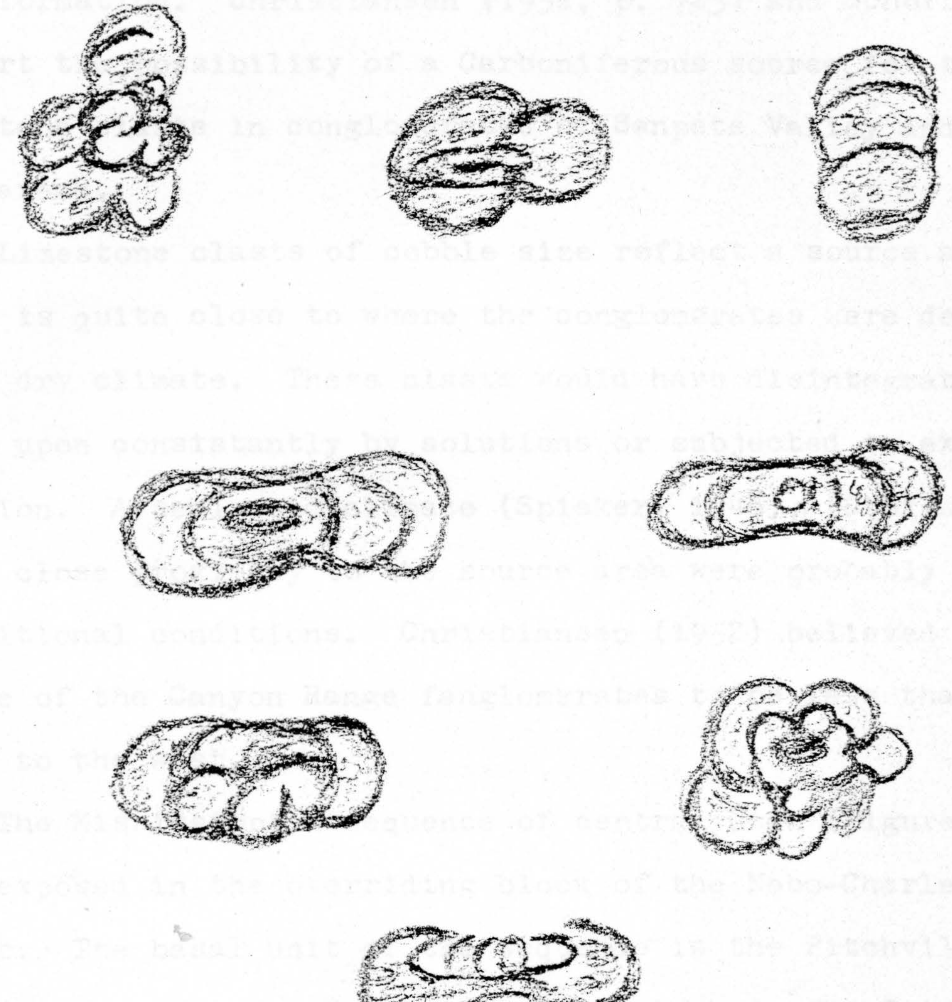

Figure 2. Sketches of unoriented sections of foraminifera drawn from thin sections UNJC 1, JC10 ?, and RJ 1.

rocks are Mississippian in age and most are derived from the same formation. Christiansen (1952, p. 725) and Schoff (1951) support the possibility of a Carboniferous source for the limestone clasts in conglomerates of Sanpete Valley and adjacent areas.

Limestone clasts of cobble size reflect a source area of which is quite close to where the conglomerates were deposited and a dry climate. These clasts would have disintegrated if acted upon consistantly by solutions or subjected to extensive abrasion. A semi-arid climate (Spieker, 1946), (Stokes, 1944) and a close proximity to the source area were probably the depositional conditions. Christiansen (1952) believed the source of the Canyon Range fanglomerates to be less than five miles to the west.

The Mississippian sequence of central Utah (Figure 3) is best exposed in the overriding block of the Nebo-Charleston thrust. The basal unit of the sequence is the Fitchville Formation. Above the Fitchville Formation, is the Gardison Limestone, the Deseret Limestone, the Humbug Formation, the Great Blue Limestone and at the top, is the Manning Canyon Shale. The Fitchville and Gardison Formations are Lower Mississippian in age and correspond to the Madison Limestone of the Wasatch Range. Mississippian formations of central Utah were miogeosynclinal limestones and dolomites which grade into shelf facies of the central Wasatch and Colorado plateaus (Armstrong, 1968).

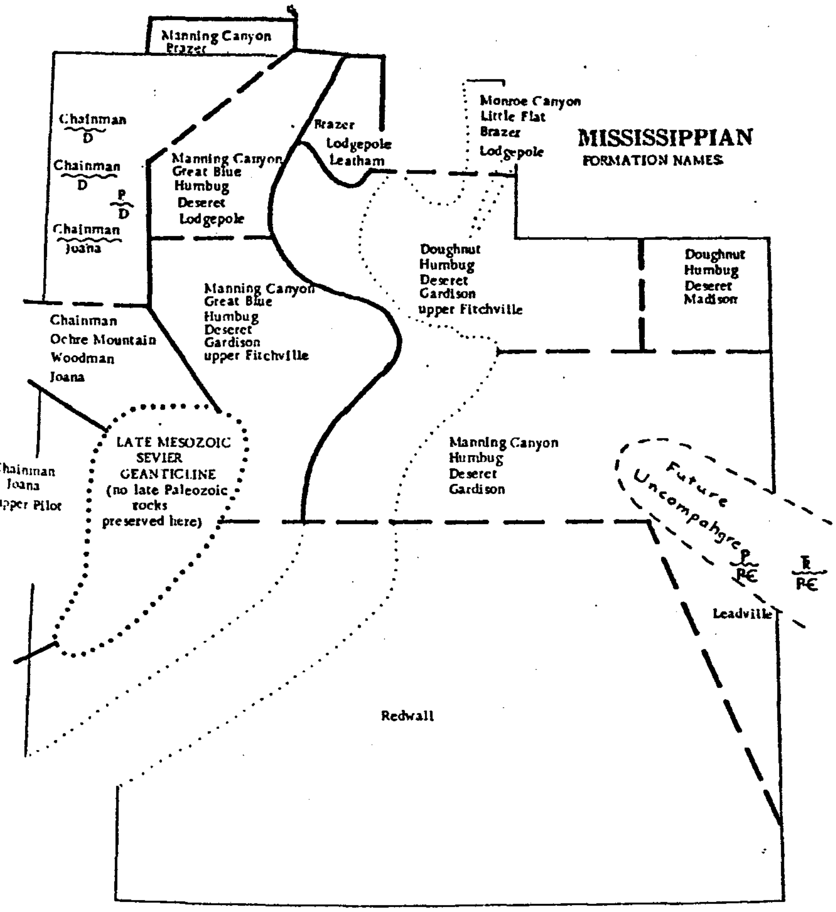

Figure 3. Distribution of Mississippian formations of Utah (from Hintze, 1976).

Comparison of lithological descriptions of Mississippian formations in central Utah (Table 1) and adjacent areas (McKee, 1969), and by a tentative identification of the endothyroid genus Granuliferella occurring in limestone clasts and cobbles from the Morrison (?) Formation of Sanpete Valley, itis concluded that the Morrison (?) limestone clasts were probably eroded from the Gardison Limestone or another Madison equivalent.

Since Mississippian limestones were one of the clastic sources of Late Jurassic (?) and Early Cretaceous conglomerates, they must have been involved in the thrusting of the Sevier orogenic belt. The Mississippian limestone cobbles of the Morrison (?) Formation were derived from an upper thrust plate of a large scale overthrust fault. This upper thrust plate, comprised of Paleozoic strata, was systematically eroded with younger Paleozoic sediments occurring as clasts in the oldest fanglomerates derived from an early pulse of the Sevier orogeny. Debris from the upper thrust plate was carried to the eastern margin of the Sevier orogenic belt as alluvial fanglomerates in a thick clastic wedge directly in front of the thrusted area.

Table 1

Mississippian Limestone Formations of Central Utah

(Principal sources: Brady, 1965, Hintze, 1976)

Formation	Lithology	Age		
Fitchville Formation	medium bedded, fine to medium crystalline, gray dolomite; contains remnants of crinoids, corals, and gastropods; basal beds are dolomite with scattered chert nodules; limestone at top is medium gray and micritic.	Kinderhookian	Lower	Mississippian
Gardison Limestone	dark gray, fossiliferous limestone with minor dolomite and abundant black chert nodules; limestone is more finely crystalline than dolomite; fossils include gastropods, crinoids, brachiopods, and corals.	Osagian	Lower	Mississippian
Deseret Limestone	medium dark gray limestone with a very minor amount of dolomite; common fossils are corals, brachiopods, crinoids, bryozoans, trilobites, chert nodules and lenses are present along with some shale and arenaceous beds.	Meramecian	Upper	Mississippian
Humbug Formation	consists of quartzites, sandstones, arenaceous, fossiliferous limestones and minor dolomites; light to medium gray in color.	Meramecian	Upper	Mississippian
Great Blue Limestone	interbedded terrigenous and limestone debris--shale member between two limestone members.	Chesterian	Upper	Mississippian

Appendix I

UNJC 1

General Description - abundantly fossiliferous rock containing approximately 10% microcrystalline dolomite and numerous pelloids in a sparry calcite matrix.

Allochems - crinoids, corals, fenestrate and other bryozoans, foraminifera, brachiopod and gastropod shell fragments, echinoid plates and spines.

Classification - biopelsparite

UNJC 2

General Description - 10% dolomite in euhedral rhombohedral grains with some microcrystalline dolomite; contains a small amount of hematite and some recrystallized calcite filling shell cavities imbedded in a lime mud matrix.

Allochems - recrystallized mollusk and trilobite (?) shell fragments and some bryozoans.

Classification - sparse biomicrite

JC10 ?

General Description - abundantly fossiliferous pelloidal limestone; pelloids compose more than 50% of the rock; fossils and pelloids are imbedded in a sparry calcite matrix with a minor amount of hematite.

Allochems - bryozoans, echinoid plates (and spines), brachiopod and mollusk shell fragments, foraminifera; bryozoans and brachiopods dominate.

Classification - biopelsparite

JC10 ? - 2

General Description - extremely fossiliferous; fossils in a sparry calcite matrix 5% hematite or limonite with 5% dolomite in euhedral rhombohedral grains.

Allochems - bryozoan and brachiopod fragments dominate.

Classification - biosparite

JC 16

General Description - matrix is hematite and lime mud with some silt grains, sparsely fossiliferous.

Allochems - echinoid plates, non-distinguishable shell fragments.

Classification - sparse biomicrite

JC 13

General Description - fine-grained sparry calcite with 25% subhedral rhombohedral grains of dolomite evenly distributed.

Classification - dolosparite

JC 12

General Description - large patches of dolomite in the form of euhedral rhombohedral grains; lime mud matrix becoming pelloidal in spots and partially recrystallized.

Classification - dolomicrite

JC 25

General Description - the limestone is dominated by brachiopod and bryozoan fragments; the cement is sparry calcite with more than 10% dolomite.

Classification - biosparite

RJ 1

General Description - extremely fossiliferous pelloidal and dolomitic limestone; cement is sparry calcite with dolomite occurring in a single patch.

Allochems - brachiopods, echinoid plates and spines, crinoids, bryozoans, foraminifera.

Classification - biopelsparite

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