EXPANDED STRATIGRAPHIC DISCUSSION – DATA REPOSITORY ITEM 2003139, FOR: Widespread Effects of Middle Mississippian Deformation in the Great Basin of Western North America

PROPOSED STRATIGRAPHIC TERMINOLOGY FOR MISSISSIPPIAN ROCKS OF THE ANTLER FORELAND IN NEVADA

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Mississippian stratigraphic names in the Great Basin are a source of frustration because of regional stratigraphic differences and gross lithologic similarities throughout thick sections. For instance, all Mississippian black shale intervals are commonly called Chainman Shale, and all Mississippian conglomerate sections are commonly called Diamond Peak Formation. These names have been applied without regard to stratigraphic position, age or genetic significance (Fig. 1 in main text).

In this paper, we discuss a revised terminology for middle and upper Mississippian rocks of the Antler foreland. The intent of the new terminology is to: (1) abandon or redefine names where units contain regionally significant unconformities, and (2) select formation names that are restrictive enough in thickness and extent that they also have relatively restricted age-ranges. We have chosen the existing names that are lithologically the most representative in the region where they occur. In some cases, we have chosen relatively obscure names, mainly because they lack a history of (mis)interpretation. In several cases, widely applied names are restricted -- both geographically and temporally -- or completely abandoned for specific areas. We introduce two new stratigraphic names (the newly defined Captain Jack and Gap Wash formations with type sections on the Nevada Test Site) where lithology and genetic relations are truly different and previous use of regional (or even local) names is incorrect, or misleading. In some areas, names that we believe represent genetically

equivalent strata may be interchangeable. We do not consider this a problem, because choice of either name will confer a consistent genetic interpretation. Our approach sacrifices simplicity, but accommodates and emphasizes regional variations and defines the stratigraphic detail necessary to interpret the regional tectonic evolution.

The following discussion is organized first by geographic area, and then by ascending stratigraphic order. For each geographic area, we first assess the existing nomenclature, and then propose names that are most useful for describing and interpreting these strata. Stratigraphic names are in boldface for ease in finding those of interest to the reader. Localities discussed in text can be found in Figure 3 of the main article.

North-central and northeastern Nevada - Carlin, Elko, Wells, and Wendover areas

In north-central and northeastern Nevada, Mississippian rocks are widely (and in most places poorly) exposed in the Tuscarora, Adobe and Piñon Ranges near Carlin and Elko, in the Snake Mountains, Windermere Hills and HD Range north of Wells, in most ranges to the east, and from Wendover south along the Nevada state line (Fig. 3 in main text). Present distribution of the Paleozoic sections has been affected by Mesozoic contraction and Cenozoic extension, and only roughly represents the original spatial distribution. A representative north-central section can be found in the northern Piñon and Adobe ranges (column #1, Fig. 4 in main text). A section representative of northeastern Nevada can be found in the Snake Mountains and the Windermere Hills north of Wells, Nevada. Still farther east, sections typical of eastern Nevada and western Utah can be found in the Goshute Mountains west of Wendover.

In north-central Nevada, earliest Mississippian (Kinderhookian through middle Osagean) time is represented by the **Webb Formation**, a fine-grained siliciclastic unit. We continue the use of this name. The Webb is exclusively a north-central and central-Nevada unit, found in association with strata of the Roberts Mountains allochthon, and is generally not found conformably overlying Devonian continental shelf strata. Most workers consider it an Antler foredeep keel deposit. In northeastern Nevada, the lower Mississippian is represented by the **Tripon Pass Formation**, and we retain this local

name for these distinctive carbonate-clast turbidites. Tripon Pass Formation rocks are preserved in a limited area north and east of Wells, and lie conformably on Devonian miogeoclinal carbonates. They represent a carbonate-clast dominated submarine fan of limited geographic extent (Frye, 1998); this name should not be used elsewhere for unrelated rocks of this age. Another local name we retain for a lithologically distinctive unit is **Camp Canyon Formation** (Smith et al., 1990), a sandy, high-energy and shallow-water carbonate unit of Kinderhookian age found in a limited area in the southern Tuscarora Mountains north of Carlin.

Kinderhookian strata are overlain by a widespread siliciclastic section throughout north-central and northeastern Nevada; we refer to this as the **Melandco Formation**. The type Melandco was defined in the southern Snake Mountains north of Wells (Thorman and Brooks, 1988). There it is a section of heterolithic conglomerate, litharenite and shale. It is interpreted as submarine fan deposits derived from the Roberts Mountains allochthon to the west. Melandco strata are presumed to be Osagean and Meramecian in age, although in most areas they are undated or the age is poorly constrained. Their age is bracketed between underlying Kinderhookian strata (the Tripon Pass Formation) and unconformably overlying lowest Chesterian strata. The Melandco represents the Antler foredeep basin fill in north-central Nevada. This unit can be recognized in ranges near Wendover and east into northwestern Utah.

Rocks we call Melandco were previously mapped by various workers as Chainman Shale, Tonka Formation or Diamond Peak Formation, as well as Melandco. These Osagean - Meramecian rocks should not be called Tonka or Diamond Peak Formation because the type sections of both of Tonka and Diamond Peak contain the regionally important C2 unconformity. We have restricted these terms to rocks above the C2 boundary. Neither should these mid-Mississippian strata be called Chainman Shale. Chainman Shale in its type section in the Egan Range is late Meramecian through Chesterian age.

The C2 unconformity separates the Melandco (our usage) from overlying Mississippian strata we refer to as Tonka Formation. As used by us, the **Tonka Formation** is uniformly Chesterian in age, and contains good biostratigraphic control in

many places (Fig. 4, main text). The Tonka comprises interbedded heterolithic conglomerate, litharenite, and limestone in facies interpreted as deltaic and shallow marine. Calcareous litharenite and limestone beds within the Tonka Formation are abundantly fossiliferous in many places. The top of the Tonka Formation is marked in all cases by a pronounced shift to carbonate-dominated strata of the Moleen Formation or equivalent Ely Limestone. We restrict the name Tonka Formation to the Chesterian conglomerate, sandstone, and limestone above the C2 boundary. Previously, these strata have either been mapped as part of the Tonka Formation (e.g., Dott, 1955) or have been renamed **Diamond Peak Formation** (e.g., Smith and Ketner, 1978). Neither the "Tonka Formation" or the "Diamond Peak Formation" is usable as originally defined because both contain the regional C2 unconformity.

Central Nevada - Eureka area to Ely

In central Nevada, Mississippian rocks are exposed in the Fish Creek Range, Diamond Mountains, Buck Mountain, Pancake Range, and White Pine Mountains (Fig. 3 in main text). Mississippian strata are also present in most ranges farther east, in the Ely area. The Mississippian stratigraphic section in the Diamond Mountains is complete and relatively well exposed, and so is used here as a representative section of Mississippian rocks in the western part of the area (Fig. 4, main text).

The lowest Mississippian (Kinderhookian) strata in the Diamond Mountains are fine-grained siliciclastic rocks of the **Pilot Shale**, which is late Famennian and earliest Kinderhookian in age (Nolan et al., 1971). The Late Kinderhookian **Joana Limestone** is also found here, although it crops out discontinuously. In the southeastern Diamond Mountains, Silberling et al. (1997) defined and mapped the **Island Mountain Formation** of latest Kinderhookian and Osagean age. This unit consists of alternating intervals of hemipelagic limestone, fine-grained siliciclastic rocks, and subordinate debris-flow beds indicating an eastern sediment source. Farther east, in the White Pine Mountains, Kinderhookian and lower Osagean time is represented by the Joana Limestone, largely a shallow-marine carbonate-platform deposit (Crosbie, 1997).

In the southern Diamond Mountains near Eureka, Webb, or Island Mountain and/or Joana strata are conformably overlain by lower Mississippian siliciclastic rocks we refer to as the **Dale Canyon Formation**. The term "Dale Canyon" serves the same stratigraphic purpose as "Melandco" to the north (discussed above), incorporating a thick section of heterolithic conglomerate, litharenite, and shale. The name "Dale Canyon" was originally applied to lower Mississippian argillite and litharenite in the southern Diamond Mountains by Nolan et al. (1956). Dale Canyon, as expanded in areal extent by us and many others (e.g., Silberling et al., 1997; Carlisle and Nelson, 1990), is Osagean and Meramecian in age, and like the Melandco is poorly dated in most areas; its age is known mostly from bracketing ages of adjacent strata.

Rocks we call Dale Canyon Formation are below the C2 boundary and have previously been mapped as Chainman Shale and Diamond Peak Formation (e.g., Lisenbee, 2001). We specifically abandon the term "Chainman Shale" for fine-grained strata in the Dale Canyon Formation. In contrast, shale intervals within the Dale Canyon formation are interpreted as distal and interchannel submarine fan deposits within the lower Mississipian foreland succession. "Diamond Peak" has been expanded by many workers to include all Mississippian conglomerate of any age or depositional setting; we restrict its use to siliciclastic strata above the C2 boundary and below the limestone-dominated Ely or Moleen formations.

Rocks overlying the C2 unconformity are Chesterian age conglomerate, sandstone, and limestone we refer to as **Diamond Peak Formation**. The name "Diamond Peak" was used by Nolan et al. (1956, 1971) for all Mississippian conglomerate and litharenite. Like the Tonka, Diamond Peak sections as originally described contain the C2 angular unconformity. The Diamond Peak redefined comprises conglomerate, litharenite, and limestone interpreted as deltaic to shallow marine deposits (Perry, 1994; Crosbie, 1997). Age control on the redefined Diamond Peak is generally good, with biostratigraphic control in interbedded carbonates throughout the section indicating a range of Chesterian ages. In the Diamond Mountains, Diamond Peak strata are conformably overlain by lower Pennsylvanian Ely Limestone (Fig. 4, main text).

In the White Pine Mountains, east of Eureka, Osagean and Meramecian age strata have not been directly documented, although many workers have invoked their presence based on lithostratigraphy, or have mapped faults based on their absence. The coarse Dale Canyon conglomerates of the Diamond Mountains are entirely missing. Measured sections of Mississippian strata show Kinderhookian Joana Limestone overlain by a thick, fine-grained siliciclastic section with Chesterian fossils (column 3 on Fig. 4, main text) (Crosbie, 1997). The section is incomplete, and probably faulted at the top of the Joana. The Chesterian, Diamond Peak-equivalent strata (our definition) are assigned to the **Chainman Shale**. They include a significant thickness of shale, thin intervals of litharenite and fine conglomerate, and beds of quartz arenite. The contact between the Gap Wash and the overlying Chainman occurs at the base of the lowest quartz arenite bed.

In the Ely area, still further east, the Mississippian is entirely represented by the **Chainman Shale** (Fig. 4, main text; Spencer, 1917). The type Chainman Shale includes interbeds of quartz arenite, but has no conglomerate or litharenite (Sadlick, 1960; Trexler et al., 1995; Trexler and Cashman, 1997). The Chainman was originally believed to be restricted to the Chesterian, and near Ely the section at Ward Mountain is restricted to this age (Fig. 4, main text). We cannot rule out the possibility that here the lower Mississippian is locally faulted out. To the north in the Cherry Creek Mountains and to the south in the southern Egan Range, fine-grained siliciclastic rocks (including the lower Mississippian Needle Siltstone) separate the Kinderhookian Joana Limestone from overlying Pennsylvanian strata. In the southern Egan Range, strata above the Needle contain Meramecian ammonoids (A. Titus, pers, commun., 2002) and should be assigned to the Gap Wash Formation.

Scotty Wash (Westgate and Knopf, 1932) quartz arenite beds are diagnostic of the Chainman, although these lithosomes are not persistent over great distances and occur several times in most sections throughout eastern Nevada (Trexler et al., 1995, 1996). These quartz arenite beds are interpreted as sand sheets that prograded westward across the shelf during eustatic lowstands. Scotty Wash quartz arenite beds are Chesterian in age, based on ammonoid collections from surrounding shales (A. Titus, pers. commun., 2002).

Southern Nevada - Nevada Test Site

In southern Nevada, Mississippian rocks record three different depositional settings -- from west to east, submarine fan, continental shelf, and carbonate platform -- each of which has a distinctive stratigraphy (Trexler et al., 1996; Trexler and Cashman, 1997; and references cited therein). These sections have been structurally juxtaposed by a complex series of deformational events (Cole and Cashman, 1999). Figure DR1 is a generalized geologic map (after Cashman et al., 2000) showing structural juxtaposition of the central (continental shelf) and western (submarine fan) sections on the Nevada Test Site (NTS). The eastern Mississippian section is exposed in the Spotted Range to the southeast of the NTS (Fig. 3 and 4, main text). Although the C2 unconformity is well developed in the carbonate platform in these sections to the east, the other two sections, farther northwest, are notable in that deposition was continuous from Osagean through Chesterian time, with no pre-Chester unconformity. Nomenclature is a problem here because the previously used stratigraphic names (Eleana and Chainman) were both defined as spanning the entire Mississippian without regard to lithofacies (Fig. 1 in main text; e.g., Poole et al., 1961, 1965; Trexler et al., 1996).

The western -- submarine fan -- section is represented by the Mississippian **Eleana Formation** (Fig. 4 in main text, Eleana Range) between Carbonate Wash and Bare Mountain. Fan deposition begins with carbonate-clast breccias and quartz sand-bearing beds containing Famennian-age conodonts. These are interpreted as submarine debris-flow and turbidity-current deposits. They are conformably overlain by an unnamed section of chert, fine sandstone and calcareous siltstone that may be correlative with the lower Mississippian Webb Formation. This in turn is overlain by a thick turbidite section that is mapped as Eleana Formation: heterolithic conglomerate, chert-litharenite, and shale that is the age and facies equivalent of the Melandco and Dale Canyon formations to the north.

There is a distinctive, and mappable, lithologic change upward within this turbidite section to intervals of carbonate clast-dominated rocks. These carbonate-clast turbidites typically contain early Chesterian fauna, and document a significant shift in

provenance near or at the time equivalent to the C2 boundary. Older carbonate-clast turbidites with Osagean fauna, possibly recycled, are present in some parts of the Eleana Formation, but carbonate-clast beds are conspicuous in all Chesterian-age sections. Although the C2 boundary is may thus be mappable throughout the area based on the lithologic change, the entire section has previously been referred to as the Eleana Formation because deposition appears continuous throughout. This Paleozoic section is everywhere terminated upward by a fault or an erosional surface; there is no known occurrence of younger Paleozoic strata overlying this section in the NTS area.

The Chesterian-age carbonate turbidites in the NTS area are not found elsewhere. They comprise a section over 100 m thick, mappable for several kilometers along the Eleana Range, at Mine Mountain (Fig. DR1), and north along the flank of Quartzite Ridge. They also crop out 90 km to the southwest, at the top of the preserved Mississippian section at Bare Mountain in Tarantula Canyon. Their geographic and stratigraphic positions are important, warranting a new stratigraphic name. We propose that these strata be referred to as the **Captain Jack Formation**, named for Captain Jack Spring in the northern Eleana Range. Figure DR2a shows a composite type-section of this unit with age control. Type section locations are shown on Figure DR1.

The central -- continental shelf -- section on the NTS (Fig. DR1, Syncline Ridge) lies disconformably on Late Devonian Guilmette Limestone (Trexler et al., 1996). The lower interval comprises fine black siltstone and shale with thin, very fine graded litharenite beds. Sparse, thin bioclastic limestone beds are present in the section, but fine siltstone and shale are overwhelmingly predominant for over 1000m of section. Medium-grained quartz-arenite beds appear in the upper part of this shale section and are more common and thicker upward. These quartzite intervals near the top of the section contain plant material, root impressions, and shallow-water sedimentary structures. The age control on most of this section is sparse and poor, being mostly from scattered pollen and conodont collections in the middle and upper parts of the unit that generally indicate Osagean-Meramecean through Chesterian ages (Trexler et al., 1996). The base of the section is probably Kinderhookian. Ammonoids provide better age control at the top of the section, and document that deposition continued into earliest Pennsylvanian time (Titus, 1992). The section is disconformably overlain by the Late Morrowan and Atokan

Tippipah Limestone, age-equivalent to the lower Pennsylvanian Ely Limestone of central Nevada.

This central-NTS Mississippian section crosses the C2 boundary without a significant break, and comprises entirely fine-grained siliciclastics. It was originally designated as "unit J" of the Eleana Formation by Poole et al. (1961, 1965), and was interpreted to be the stratigraphically highest part of the Eleana Formation. However, the section is age-equivalent to much of the Eleana Formation nearby to the west, but is lithologically dissimilar, and bound above and below by different units. We (Trexler et al., 1996) initially called the entire section Chainman Shale, but now propose the new name **Gap Wash Formation** for the lower interval below the shallow-water quartz-arenite beds, named for the drainage east of the Eleana Range where most exposures of these strata can be found (see Fig. DR2b for composite stratotype sections; locations of sections are shown on Figure DR1. (Note that continuous core from two drill-holes were selected as the stratotype because the unit is not well exposed anywhere on the NTS. These cores are preserved at the U.S. Geological Survey Core Library at Mercury, Nevada.) The lower contact is the unconformable boundary on the Devonian Guilmette Limestone which is fortuitously preserved in drill core obtained from the ER-6-2 drill hole in the northern C.P Hills (D in Fig. DR1 and DR2b. The upper boundary of the Gap Wash Formation is taken to be the lowest significant interval of quartz arenite, which is undated but may be as old as Meramecian (based on palynomorphs, see Fig. DR2b) or as young as middle Chesterian. The overlying, quartz arenite bearing shale can be mapped throughout the southern Nevada region and correlated to the Chainman Shale with its Scotty Wash quartzite members; we retain the name Chainman Shale for this upper interval.

The easternmost -- carbonate platform -- Mississippian section in the NTS area is exposed in the Spotted Range east of Mercury, Nevada (Poole and Sandberg, 1977; Barnes et al., 1982; Trexler et al., 1996). Local stratigraphic names for this unique section have been defined there, but used rarely elsewhere. Famennian through Kinderhookian time is represented by 330 meters of carbonates, much of which is late Kinderhookian in age: the Narrow Canyon, Mercury, and Timpi Canyon limestone units (Fig. 4 in main text, column 7). These strata are overlain unconformably by a Chesterian section of

calcareous siltstone, quartz-arenite-siltstone and sparse limestone. Although this Chesterian unit has been called Chainman Shale by Poole et al. (1965), it is not a shale interval, but a tan, siliceous siltstone. Based on lithology and stratigraphic position, it may correlate with the Indian Springs Formation found in the northwestern Spring Mountains, approximately 30km to the southeast.

Captain Jack Formation

The newly-defined Captain Jack Formation comprises as much as 300 meters of interbedded siliciclastic and carbonate rocks (Fig. DR2a). Fine-grained intervals are laminated siltstone and mudrock, with common bedding-plane burrows. Coarse beds range from fine litharenite to conglomerate, are commonly graded, and preserve lower-flow-regime sedimentary structures: ripple cross-laminae and small-scale cross-bedding. Clasts in coarse beds include lithic debris with rare to abundant limestone clasts and calcareous bioclastic debris, most commonly pelmatozoan stem fragments. Carbonate clasts are commonly silicified. Coarse beds generally range from 5 to 30cm thick, and occur in multiple bedsets. In general, bedding is planar and persistent laterally, and coarser beds crop out as resistant, distinctive ledges that can be traced for a kilometer or more. The age of the Captain Jack Formation is based on small foraminifera collected from calcarenite beds, and is Chesterian in the mapped areas (Trexler et al., 1996).

Captain Jack Formation strata are interpreted as submarine fan turbidites (Trexler and Cashman, 1997). The unit is distinctive in that the coarser debris is dominated by calcareous, bioclastic detritus. The source for the calcareous debris is probably a productive carbonate shelf to the east and northeast during Chesterian time. The Captain Jack Formation is correlative with the Diamond Peak and Chainman formations to the north and northeast.

Two measured sections in the Captain Jack Formation are shown in Figure DR2a. The base of the Captain Jack Formation is taken as the lowest carbonate-clast turbidite bed where the section changes significantly from the siliciclastic-dominated turbidites of the Eleana Formation. The top is either a fault or eroded in all cases examined. The

tectonic context of this unit is discussed in detail in Trexler et al. (1996) and Trexler and Cashman (1997), where it was described as a member of the Eleana Formation.

Gap Wash Formation

The newly-defined Gap Wash Formation consists of as much as 800 meters of black siltstone and mudrock with rare coarser beds of crinoidal limestone and litharenite. It is not resistant, and is not well exposed anywhere. Outcrops are commonly black, shaley slopes. Best preservation of this unit is in core recovered from exploratory wells on the NTS, which shows that this unit is chiefly a monotonous, black mudrock with thin, laminated siltstone beds. Age control is rare, but microfossil collections have yielded Osagean and Meramecian dates in the middle and upper parts of the section (Trexler et al., 1996).

The Gap Wash Formation is interpreted as hemipelagic mudrock deposited on a distal continental shelf. It is correlative with the lower Mississippian Eleana Formation, but it was deposited in an area that received almost no coarse detritus from the submarine fan system that filled the Antler foreland basin (Trexler and Cashman, 1997).

Two measured sections in the Gap Wash Formation are shown in Figure DR2b. The base of the Gap Wash Formation is a depositional contact on eroded Devonian Guillmette Limestone (preserved only in the ER-6-2 core, and possibly in UE25a-3 core from the Calico Hills (Fig. 3, main text). This is a critical relationship because it unequivocally ties the Gap Wash Formation to stratigraphy associated with the Devonian continental shelf. The upper contact is the oldest (lowest) quartz-arenite bed interpreted as the Scotty Wash member of the Chainman Shale. Fossil control both on the NTS and elsewhere (A. Titus, pers. commun.) indicates that the Chainman-Scotty Wash base is no older than late Meramecian (see main text). The tectonic context of the Gap Wash Formation is discussed in detail in Trexler et al. (1996) and Trexler and Cashman (1997), where it was described as part of the Chainman Shale.

Figure captions:

Fig. DR1. A generalized geologic map of part of the Nevada Test Site, southern Nevada (modified from Cashman et al., 2000). Circled letters indicate the locations of type sections shown on Figure DR2.

Fig. DR2. Type sections of the Gap Wash (a) and Captain Jack (b) formations newly described here, on the Nevada Test Site in southern Nevada. Letters in circles refer to localities of sections on Figure DR1.

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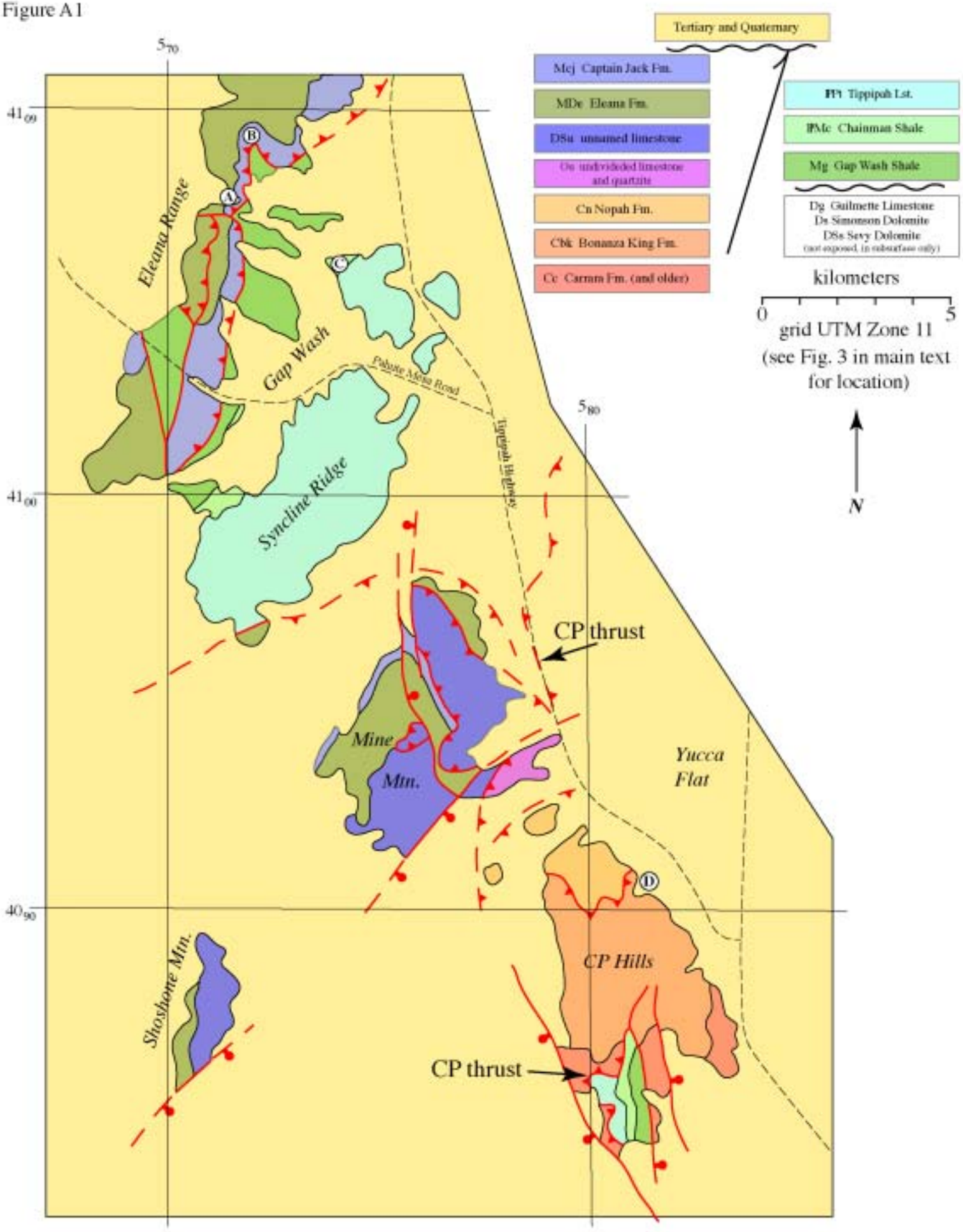
Figure A1


Tertiary and Quaternary
Mcj Captain Jack Fm.
MDe Eleana Fm.
DSu unsamed limestone
Os undivideded limestone and quartzite
Cn Nopah Fm.
Cbk Bonanza King Fm.
Cc Carrara Fm. (and older)
Tippipah Lst.
Chainman Shale
Mg Gap Wash Shale
Dg Guilmette Limestone
Ds Simonson Dolomite
DSs Sevy Dolomite
(not exposed, in subsurface only)
kilometers
0
5
grid UTM Zone 11
(see Fig. 3 in main text for location)
N
5 70
5 80
41 09
41 00
40 90
Eleana Range
Gap Wash
Pahute Mesa Road
Tippipah Highway
Syncline Ridge
CP thrust
Mine Mtn.
Yucca Flat
CP Hills
CP thrust
Shoshone Mtn.
A
B
C
D

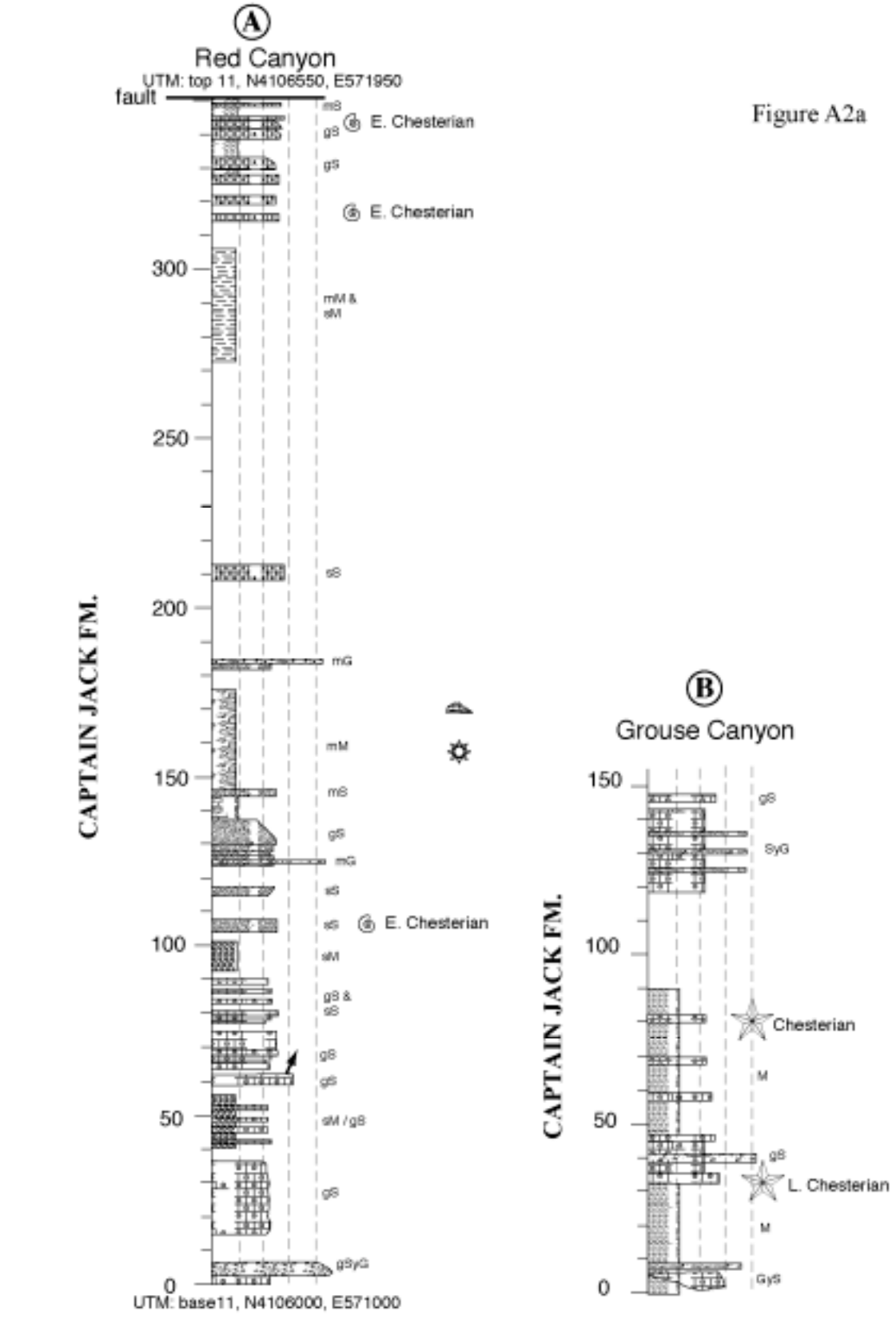
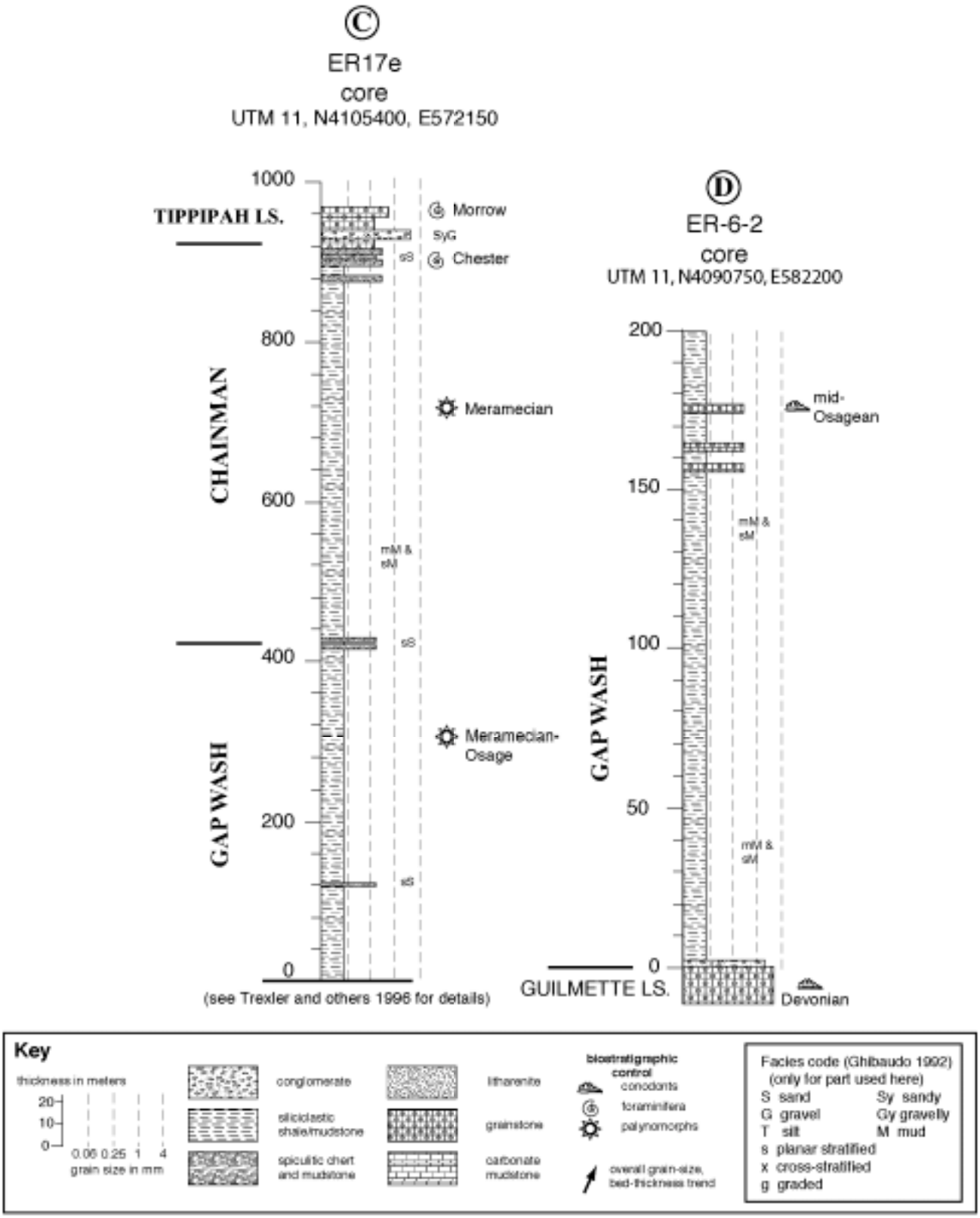

A
Red Canyon
UTM: top 11, N4106550, E571950
fault
E. Chesterian
E. Chesterian
E. Chesterian
CAPTAIN JACK FM.
300
250
200
150
100
50
0
mS
gS
gS
mM & sM
sS
mG
mM
mS
gS
mG
sS
sS
sM
gS & sS
gS
gS
sM / gS
gS
gSyG
UTM: base11, N4106000, E571000
B
Grouse Canyon
CAPTAIN JACK FM.
150
100
50
0
gS
SyG
Chesterian
M
gS
L. Chesterian
M
GyS
Key
thickness in meters
20
10
0
0.06 0.25 1 4
grain size in mm
conglomerate
siliciclastic shale/mudstone
spiculitic chert and mudstone
litharenite
grainstone
carbonate mudstone
biostratigraphic control
conodonts
foraminifera
palynomorphs
overall grain-size, bed-thickness trend
Facies code (Ghibaudo 1992)
(only for part used here)
S sand
Sy sandy
G gravel
Gy gravelly
T silt
M mud
s planar stratified
x cross-stratified
g graded

Figure A2a


C
ER17e
core
UTM 11, N4105400, E572150
1000
800
600
400
200
0
TIPPIPAH LS.
CHAINMAN
GAP WASH
Morrow
SyG
sS
Chester
Meramecian
mM &
sM
sS
Meramecian-
Osage
sS
(see Trexler and others 1996 for details)
D
ER-6-2
core
UTM 11, N4090750, E582200
200
150
100
50
0
GAP WASH
mid-
Osagean
mM &
sM
mM &
sM
GUILMETTE LS.
Devonian
Key
thickness in meters
20
10
0
0.06 0.25 1 4
grain size in mm
conglomerate
siliciclastic
shale/mudstone
spiculitic chert
and mudstone
litharenite
grainstone
carbonate
mudstone
biostratigraphic
control
conodonts
foraminifera
palynomorphs
overall grain-size,
bed-thickness trend
Facies code (Ghibaudo 1992)
(only for part used here)
S sand
Sy sandy
G gravel
Gy gravelly
T silt
M mud
s planar stratified
x cross-stratified
g graded