Sedimentology and Provenance from Upper Cretaceous Strata in Southern New Mexico: Implications for Sediment Dispersal Along the Southern Margin of the Sevier Foreland Basin*

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Abstract

Nearly continuous sections of Upper Cretaceous Sevier foreland basin strata are exposed in outcrop throughout parts of southern New Mexico. Here, Cenomanian–lower Campanian stratigraphy are defined from base-to-top by (1) fluvial and shoreline deposits of the Dakota Sandstone, (2) lower- and upper-offshore deposits of the Mancos Shale (Tokay Tongue) and Bridge Creek Limestone and Sandstone Members, (3) shoreline deposits of the Atarque Sandstone Member and fluvial strata of the Tres Hermanos Formation, (4) lower- and upper-offshore strata of the D-Cross Tongue of the Mancos Shale and lower shoreface and shoreline strata of the Gallup Sandstone, and (5) fluvial strata of the Crevasse Canyon Formation. Presented here are new sedimentologic data from the Coniacian–lower Campanian Crevasse Canyon Formation and new provenance data (sandstone modal composition and U-Pb detrital zircon geochronology) from nonmarine parts of the Dakota Sandstone, Tres Hermanos Formation, and Crevasse Canyon Formation. New sedimentary facies and architectural element analysis from the Crevasse Canyon Formation reveal an upsection transition from more meandering to braided stratigraphic architectures. The lower member of the Crevasse Canyon Formation is thought to be Coniacian–Santonian in age and is characterized by lenticular (channel) sandstone units that exhibit well-developed lateral accretion surfaces. Lenticular units are bound by tabular sandstone and pedogenically-altered mudstone deposits that are interpreted to represent floodplain crevasse splay sedimentation and paleosol development, respectively. The upper part of the Crevasse Canyon Formation (Ash Canyon Member) is thought to be lower Campanian in age and consists primarily of amalgamated lenticular sandstone units that are interpreted to represent a braided channel complex. Trends in detrital modes from the Dakota Sandstone, Tres Hermanos, and Crevasse Canyon Formations show an upsection transition from more quartz-dominated to more lithic-dominated compositions. The basal Dakota

Sandstone has a higher relative abundance of quartz compared to the Tres Hermanos and Crevasse Canyon Formations, each of which have higher relative abundances of lithic volcanic fragments and feldspar. New sedimentologic and provenance data from Upper Cretaceous strata in southern New Mexico provide a means for testing trends in exhumation and sediment dispersal along the southern margin of the Sevier foreland basin.

Selected References

Blakey, R., 2011, Library of Paleogeography: Web Accessed September 5, 2015, www.cpgeosystems.com/paleomaps.html.

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GEOLOGIC BACKGROUND

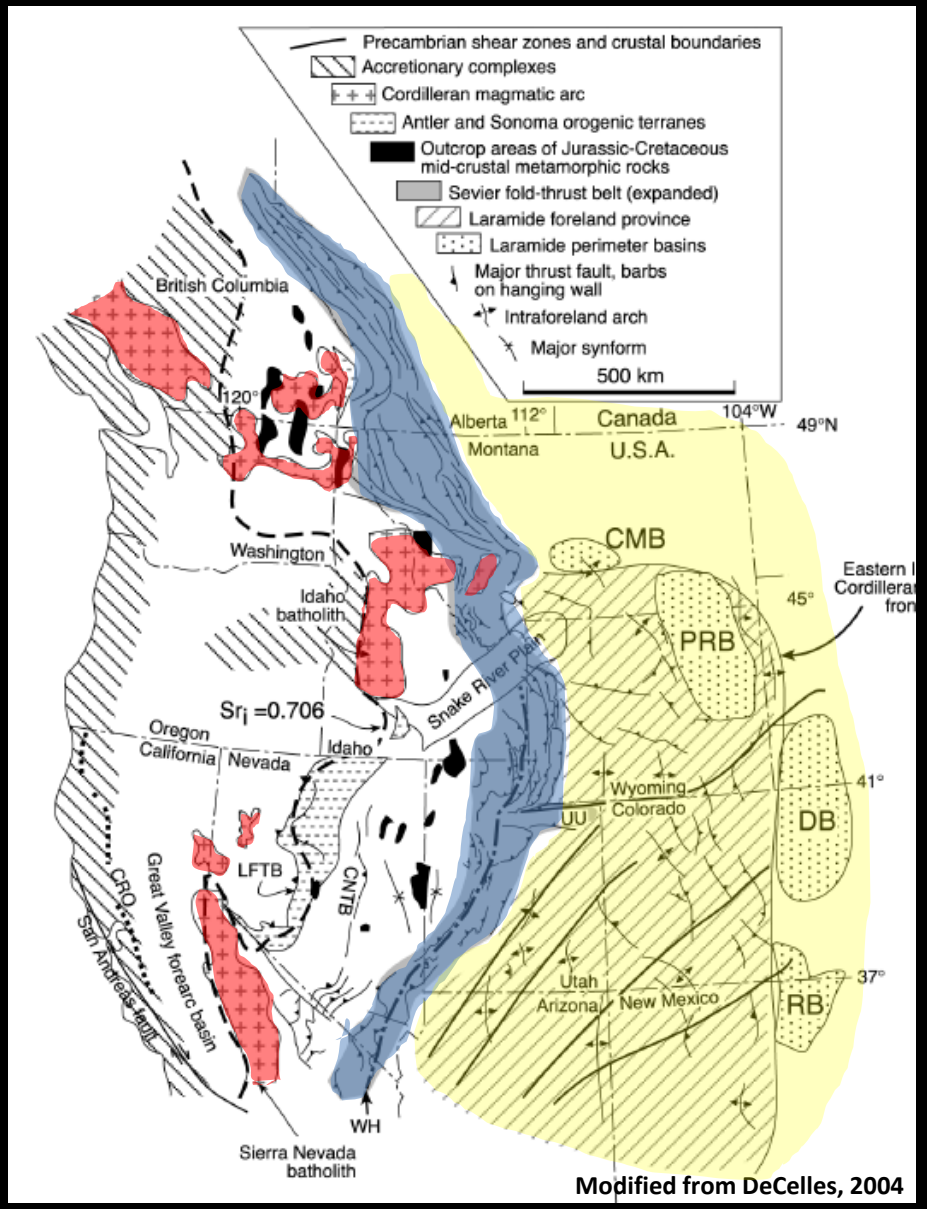
CORDILLERAN OROGENIC BELT & FORELAND BASIN

- Active from Late Jurassic to Eocene time with three main phases of sedimentation

(1) Late Jurassic-Early Cretaceous
- ~155-110 Ma
- Primarily nonmarine

(2) Early-Late Cretaceous
- ~110-70 Ma
- Primarily marine with isolated nonmarine

(3) Late Cretaceous-Eocene
- ~70-55 Ma
- Primarily nonmarine



GEOLOGIC BACKGROUND

LATE CRETACEOUS PALEOGEOGRAPHY & FOCUS OF STUDY

- Dominated by marine sedimentation with marginal marine and fluvial sedimentation along the basin margin
- Late Cretaceous sedimentation throughout much of New Mexico is marked by the Mancos Shale
- Focus of this study is on the depositional history and provenance of Late Cretaceous (Cenomanian-Campanian) nonmarine strata in southern NM

GEOLOGIC BACKGROUND

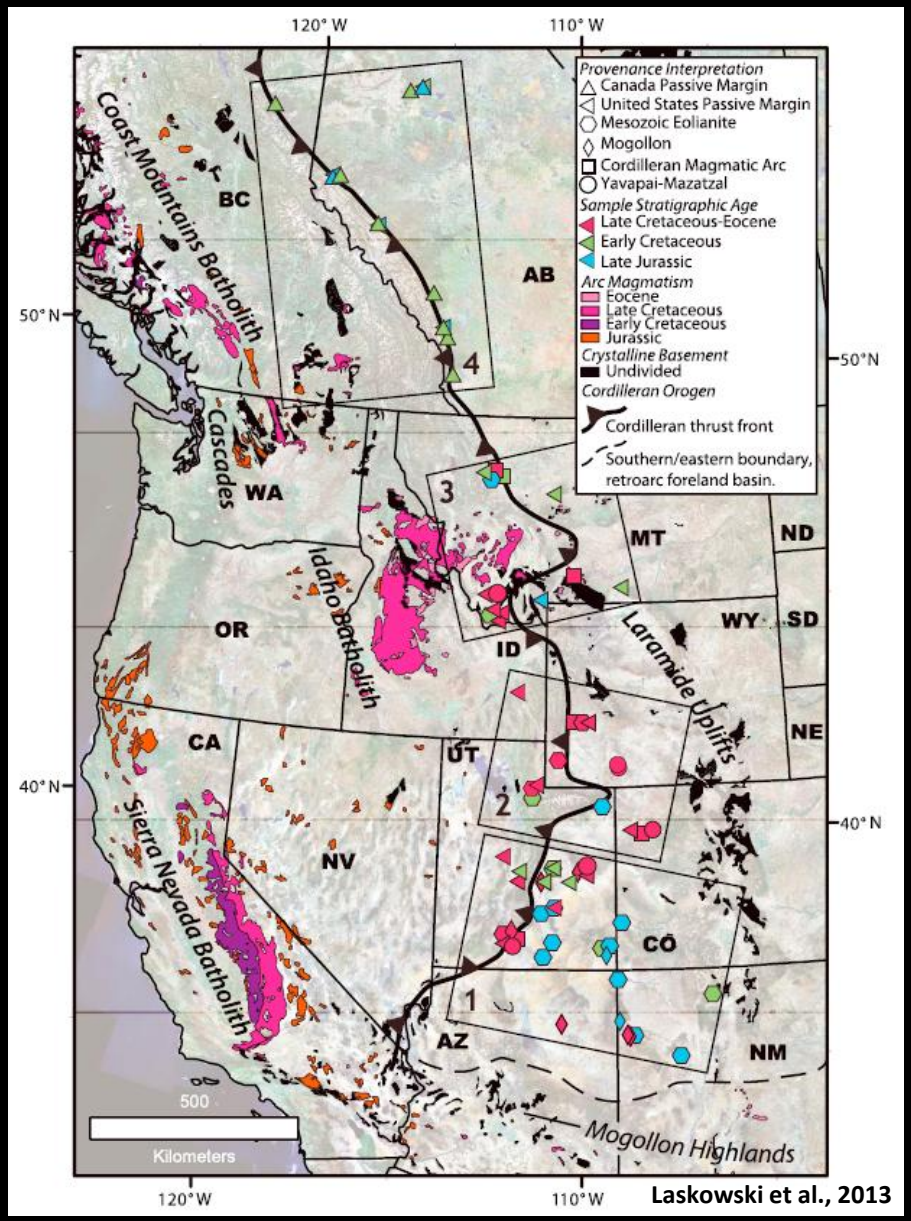
PROVENANCE TRENDS FROM THE CORDILLERAN FORELAND

(4) Northern Foreland (Canada)
- NA passive margin

(3) North-Central Foreland (Montana)
- NA passive margin
- Cordilleran magmatic arc
- Yavapai-Mazatzal

(2) South-Central Foreland (Uinta)
- NA passive margin
- Yavapai-Mazatzal
- Cordilleran magmatic arc
- Mogollon Highlands
- Mesozoic Eolianite

(1) Southern Foreland (Four Corners)
- Mogollon Highlands
- Yavapai-Mazatzal
- NA passive margin
- Cordilleran magmatic arc
- Mesozoic Eolianite



Laskowski et al., 2013

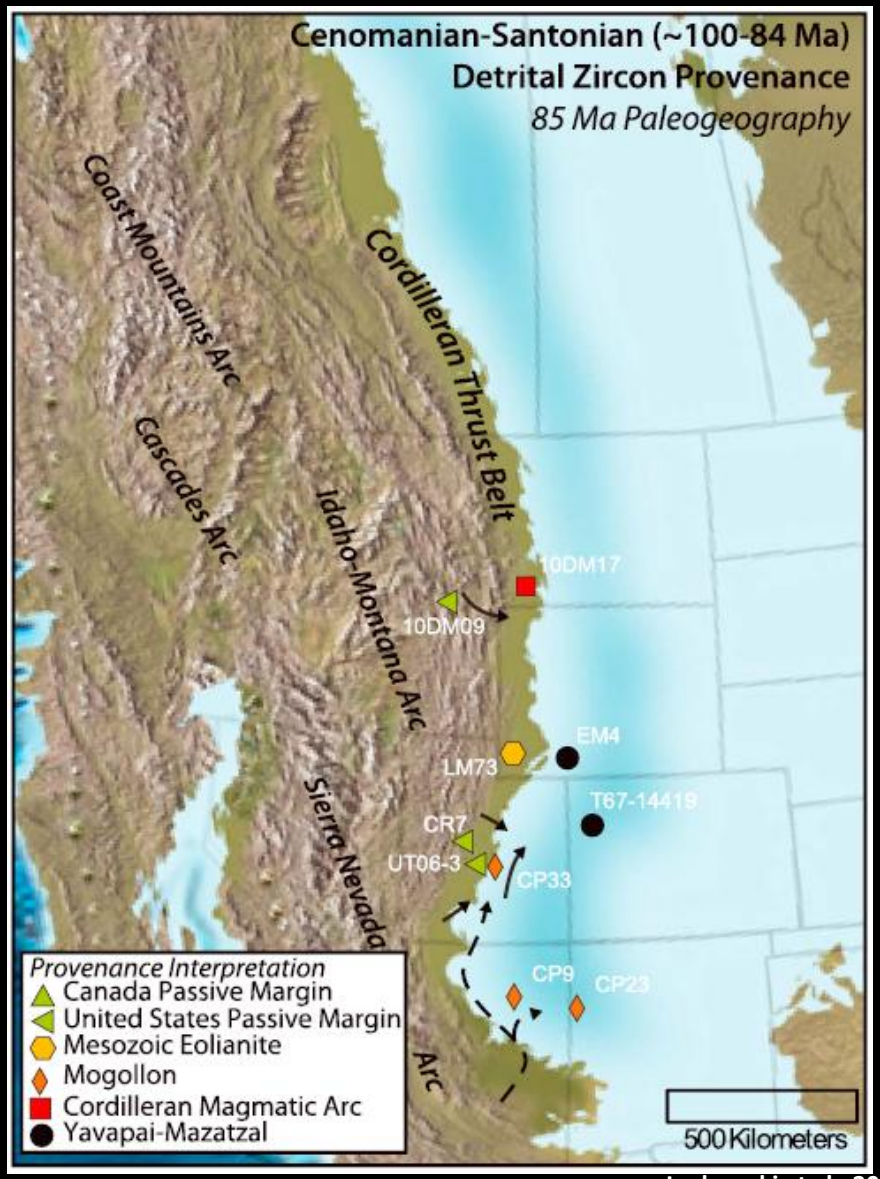
GEOLOGIC BACKGROUND

LATE CRETACEOUS PROVENANCE TRENDS

North-Central Foreland (Montana)
- Cordilleran magmatic arc
- NA passive margin

South-Central Foreland (Uinta)
- Yavapai-Mazatzal
- NA passive margin
- Mesozoic Eolianite
- Mogollon Highlands

Southern Foreland (Four Corners)
- Mogollon Highlands
- Yavapai-Mazatzal



Laskowski et al., 2013

GEOLOGIC BACKGROUND

BASEMENT & MAGMATIC PROVINCES

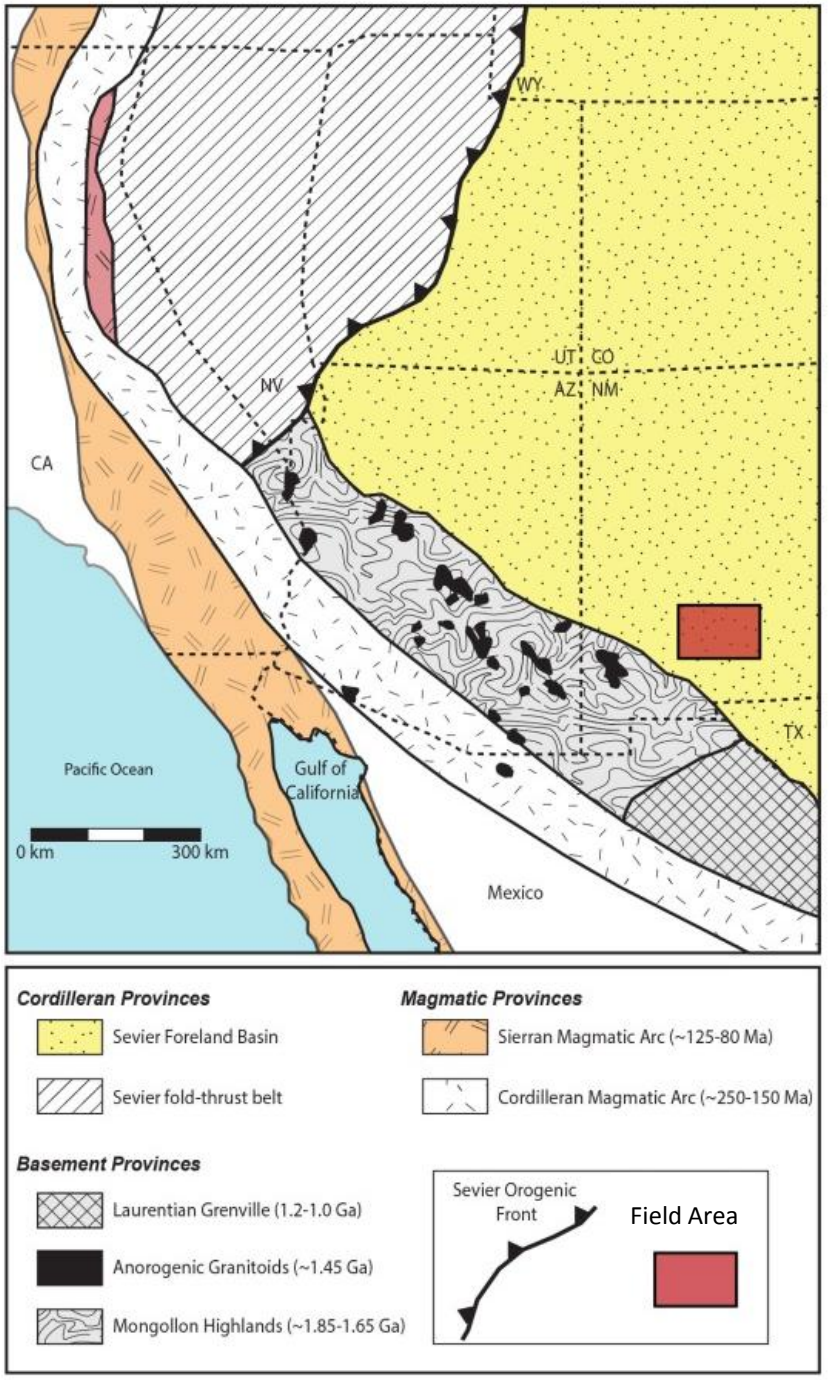
(1) Sierran Magmatic Arc (80-125 Ma)

(2) Cordilleran Magmatic Arc (150-250 Ma)
- Jurassic Arc and Rift Magmatism
- Permo-Triassic Arc Magmatism

(3) Grenville Province (1000-1300 Ma)

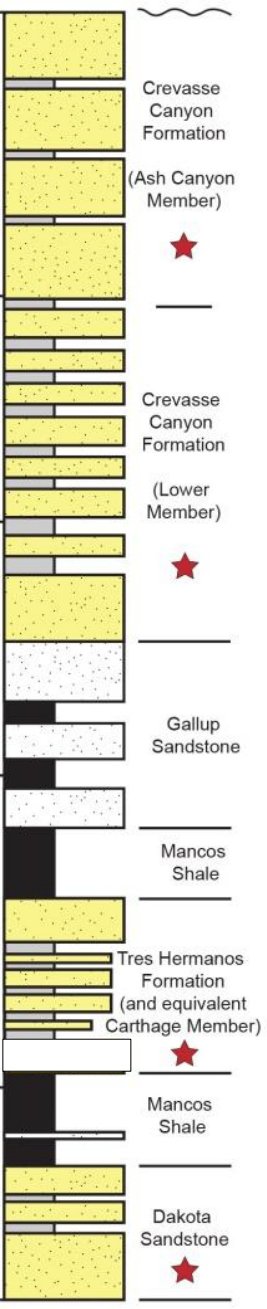
(4) Anorogenic Granitoids (1200-1500 Ma)

(5) Yav-Mazatzal/Mogollon (1600-1850 Ma)



Modified from Lawton et al., 2014

STRATIGRAPHIC OVERVIEW



(7) CREVASSE CANYON FORMATION (Ash Canyon Member)
- Santonian?-Lower Campanian
- Amalgamated fluvial channels; poorly-developed floodplain

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(6) CREVASSE CANYON FORMATION (Lower Member)
- Coniacian-Santonian?
- Fluvial channels nested in well-developed floodplain

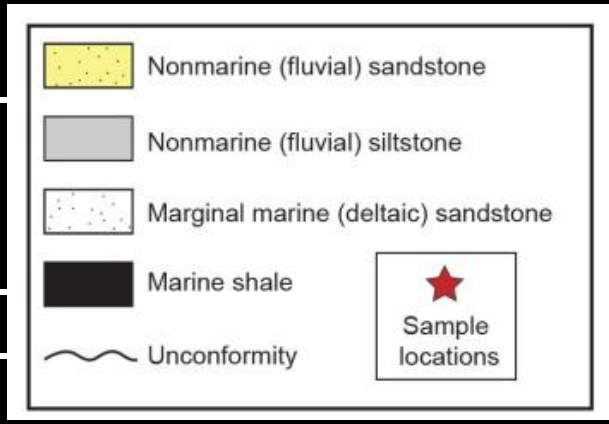
(5) GALLUP SANDSTONE
- Upper Turonian
- Marginal marine (deltaic/shoreline)

(4) MANCOS SHALE (Middle Turonian)

(3) TRES HERMANOS FORMATION
- Middle Turonian

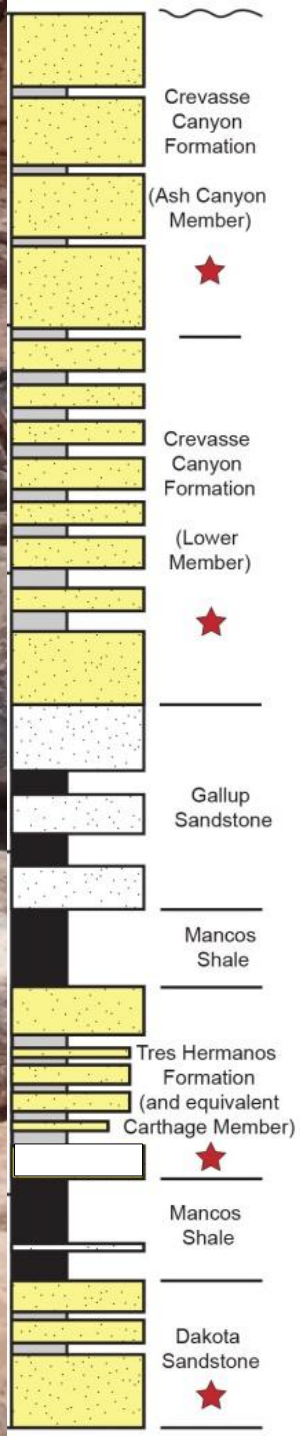
(2) MANCOS SHALE (Upper Cenomanian-Lower Turonian)

(1) DAKOTA SANDSTONE
- Middle Cenomanian



STRATIGRAPHIC OVERVIEW

Dakota Sandstone (Middle Cenomanian)



STRATIGRAPHIC OVERVIEW

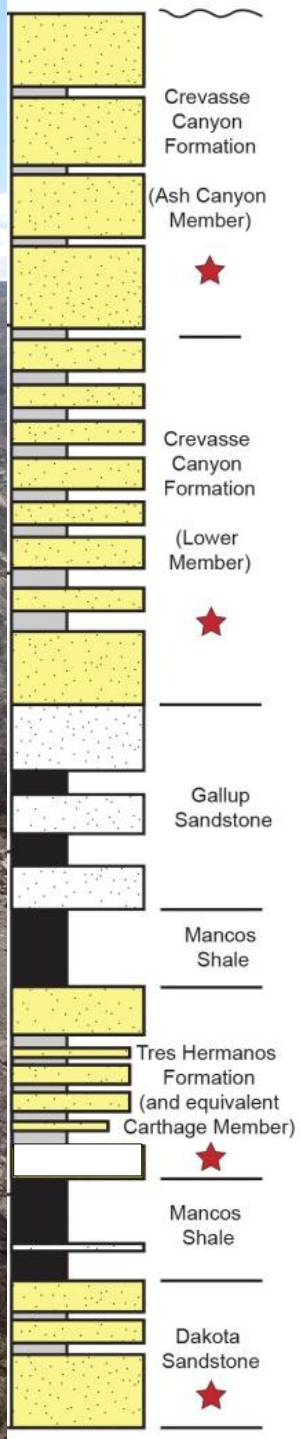
Dakota Sandstone (Middle Cenomanian)

Sedimentology - Composition - Paleocurrent Determinations

- Fine- to medium-grained sandstone and mudstone
- Lenticular and tabular bed geometries; lateral accretion surfaces
- Trough-cross stratification (St); planar-cross stratification (Sp)
- Fluvial channels with isolated point-bars; moderately-developed floodplain
- Modal Composition Trends: Dominated by monocrystalline quartz; chert
- Paleoflow Trends: Variable; north-directed flow (N10E); east-directed flow (N47E)

STRATIGRAPHIC OVERVIEW

Tres Hermanos Formation (Middle Turonian)



STRATIGRAPHIC OVERVIEW

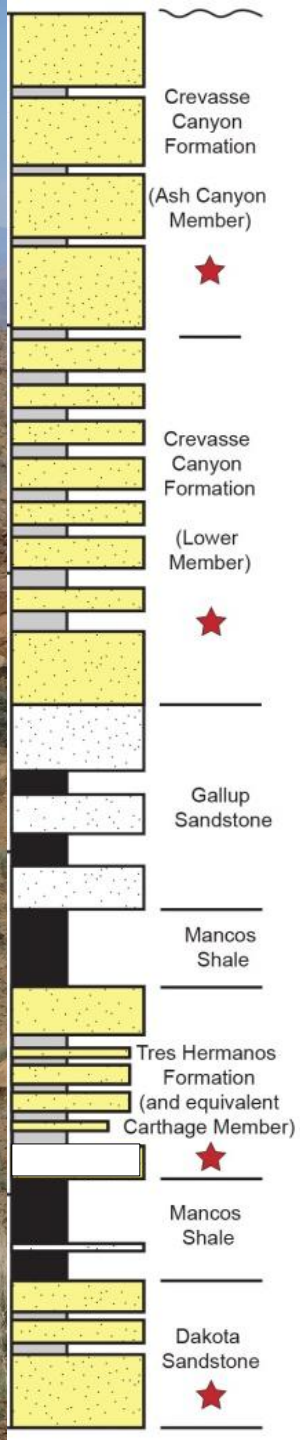
Tres Hermanos Formation (Middle Turonian)

Sedimentology - Composition - Paleocurrent Determinations

- Fine- to medium-grained sandstone and mudstone
- Lenticular and tabular bed geometries
- Trough-cross stratification (St), ripple-cross stratification (Sr), soft sediment deformation
- Fluvial channels nested in well-developed floodplain
- Modal Composition Trends: Mono and polycrystalline quartz, chert, plagioclase, lithic fragments (lithic sedimentary are most common; minor volcanic and metamorphic)
- Paleoflow Trends: East-directed flow (N72E)

STRATIGRAPHIC OVERVIEW

Crevasse Canyon (Coniacian-Lower Campanian)



STRATIGRAPHIC OVERVIEW

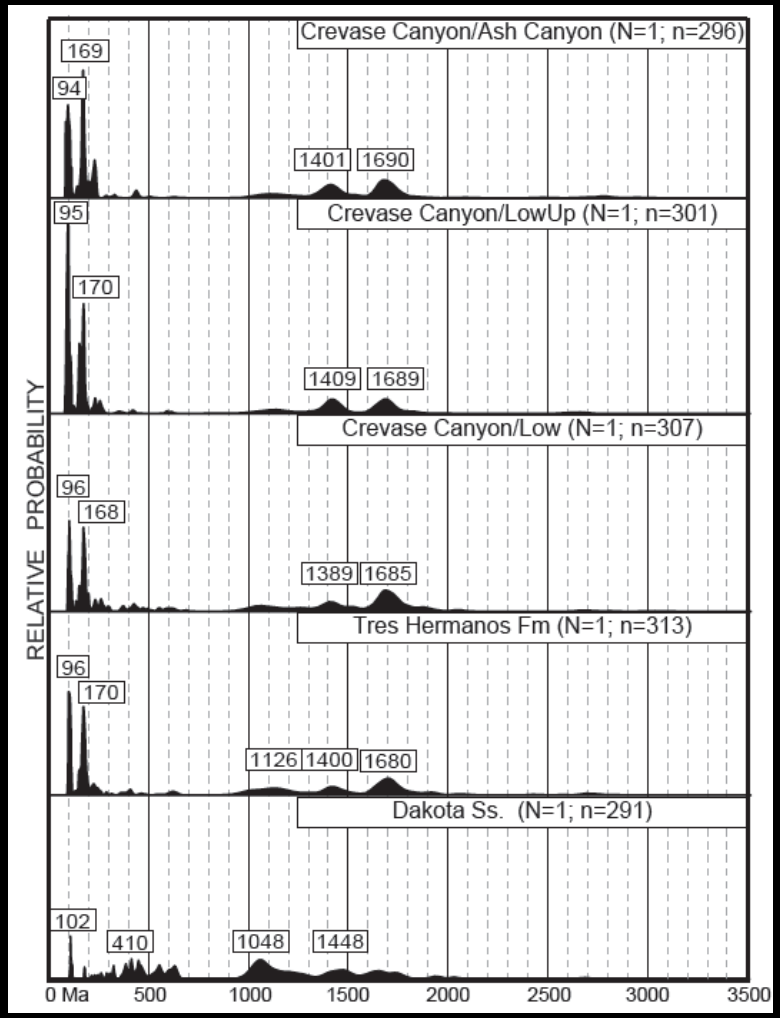
Crevasse Canyon (Coniacian-Lower Campanian)

Sedimentology - Composition - Paleocurrent Determinations

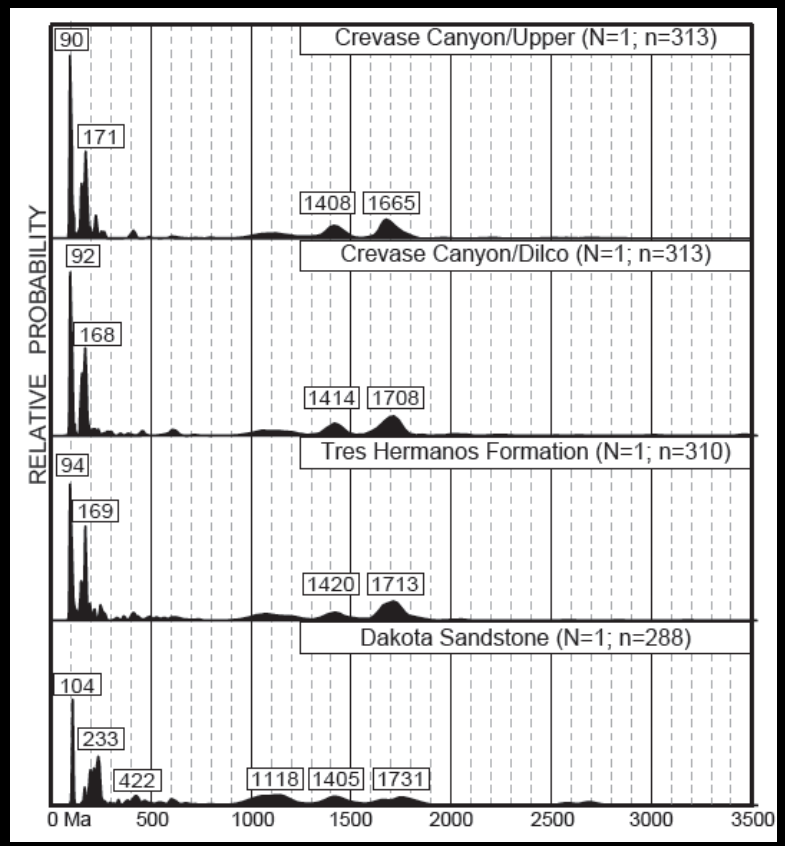
- Fine- to medium-grained sandstone and mudstone
- Lenticular and tabular bed geometries
- Trough-cross stratification (St), planar-cross stratification (Sp), ripple-cross stratification (Sr)
- Fluvial channels nested in well-developed floodplain (lower); amalgamated channels (Ash Canyon Member)
- Modal Composition Trends: Monocrystalline quartz, chert, plagioclase, lithic fragments (lithic volcanic and sedimentary are most common)
- Paleoflow Trends: East-directed flow (N85E)

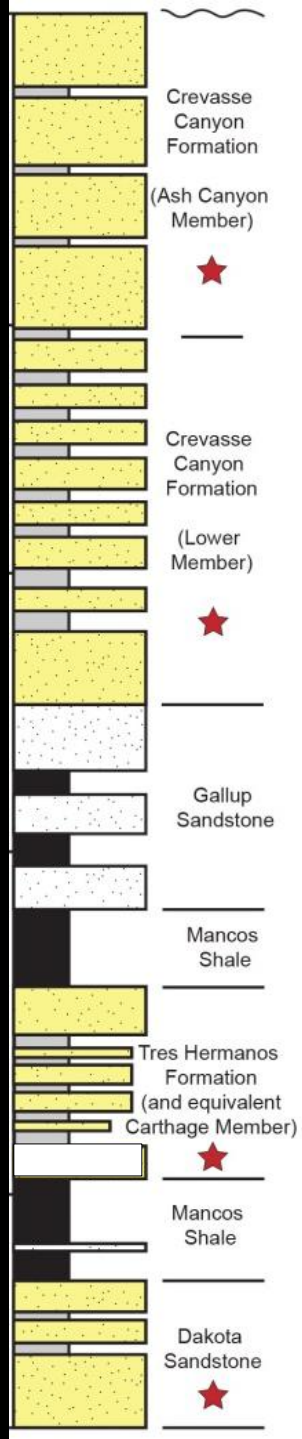
DETRITAL ZIRCON GEOCHRONOLOGY

Mescal Canyon – Field Locality
N=5, n=1508



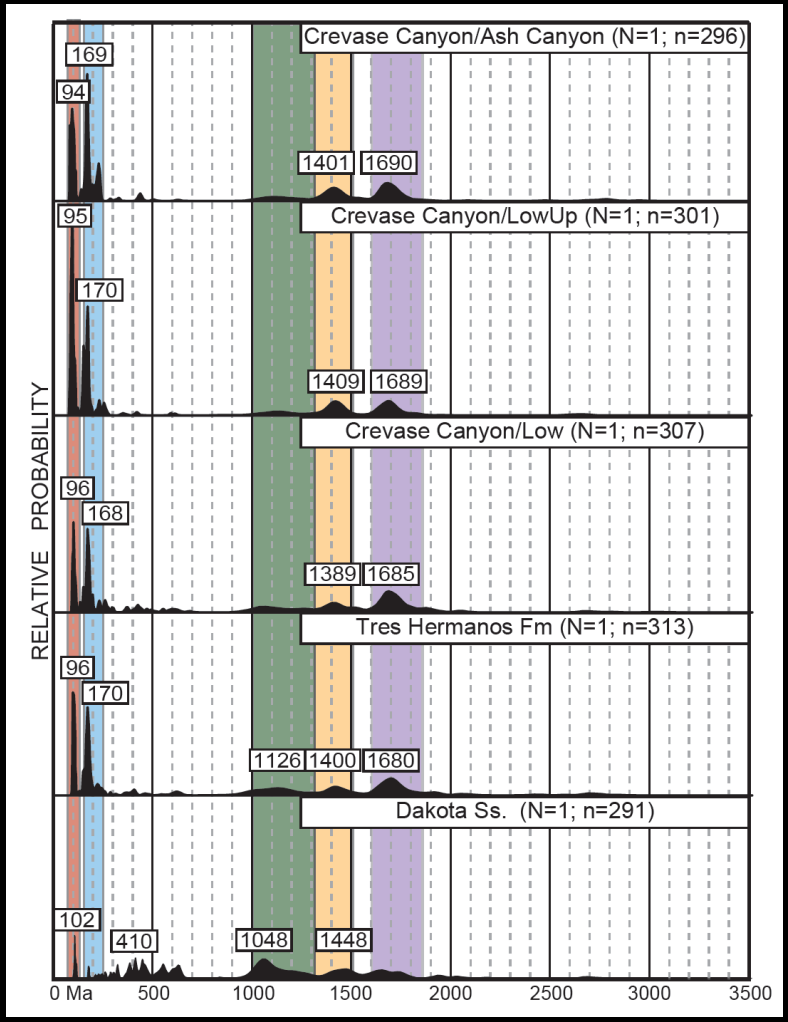
Carthage – Field Locality
N=4, n=1224

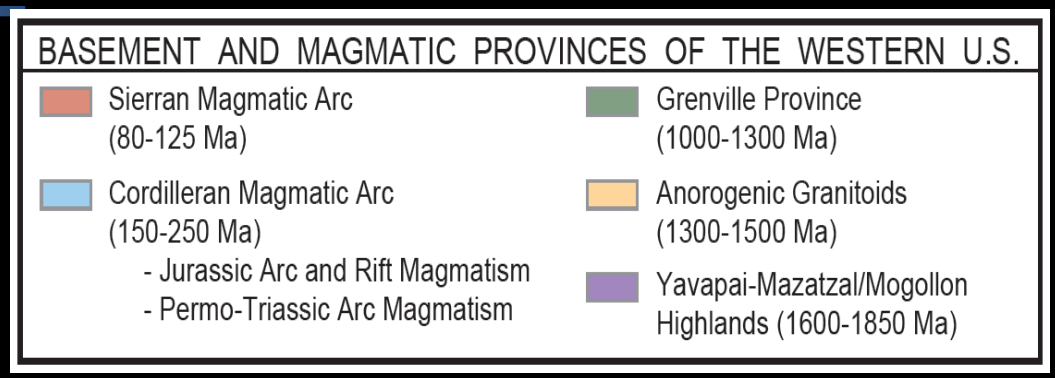




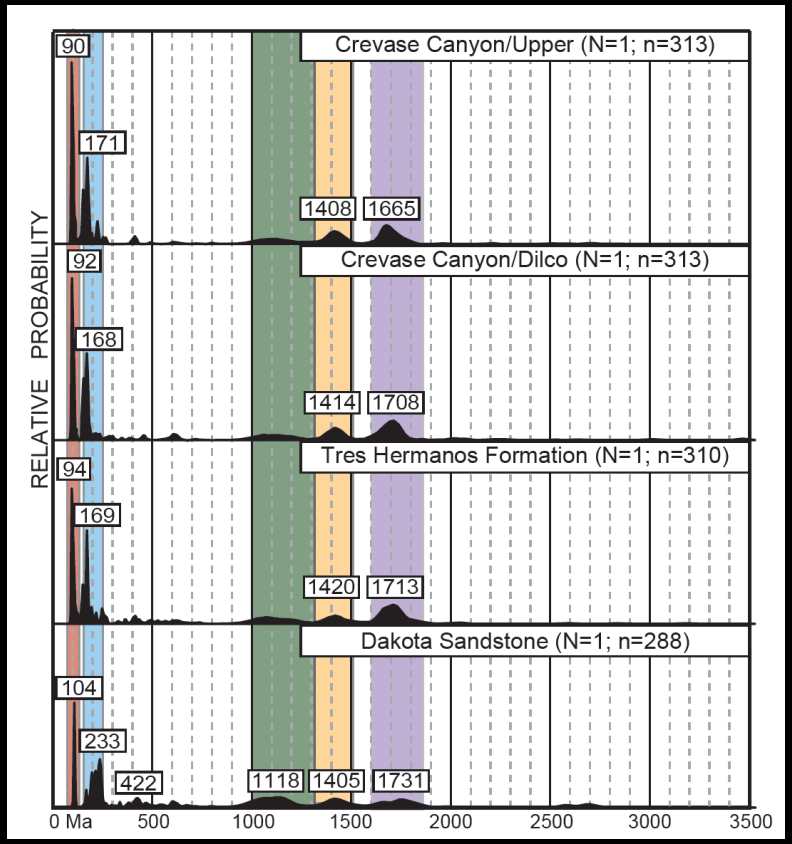
POTENTIAL SOURCE AREAS

Mescal Canyon – Field Locality





Carthage – Field Locality

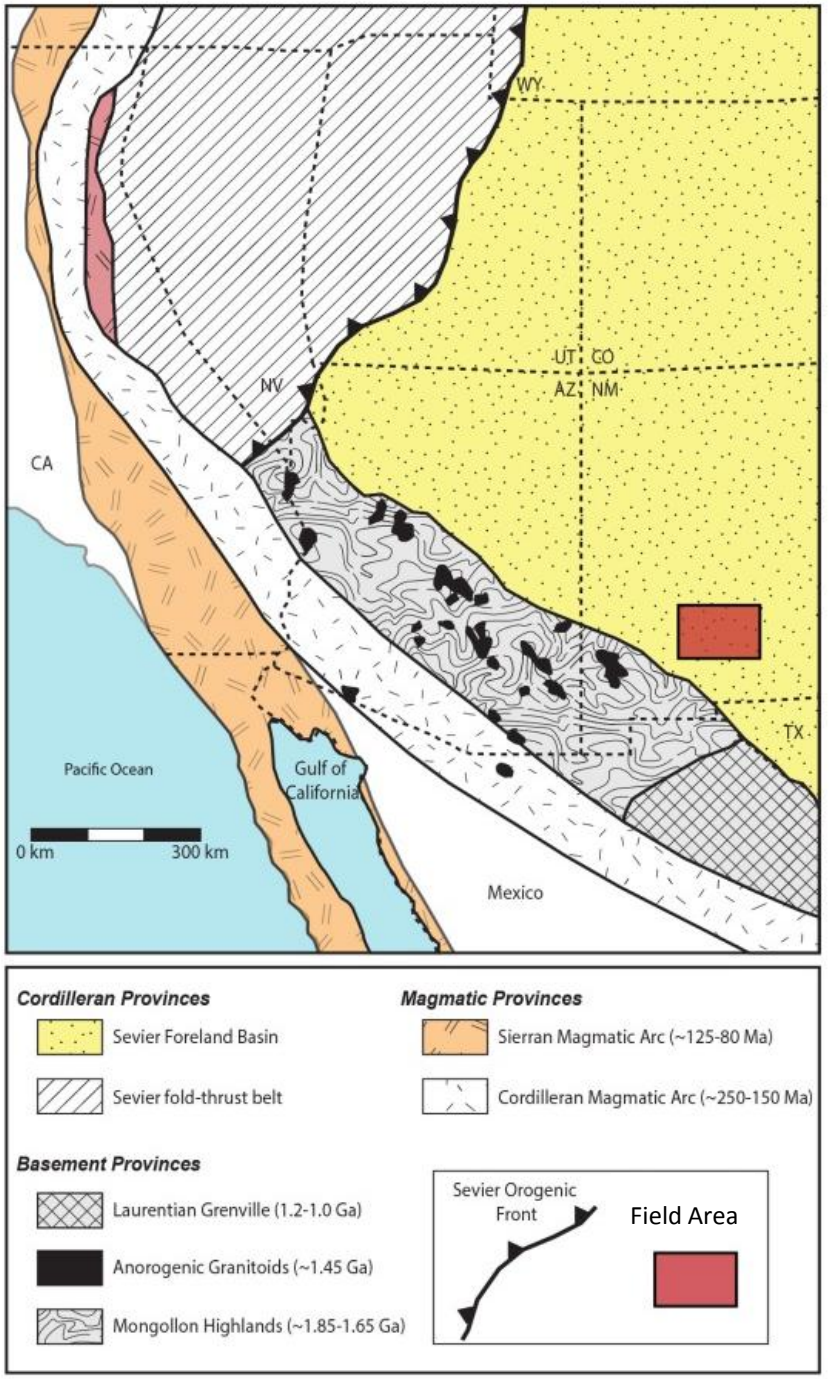


SOURCE AREA SUMMARY

Crevasse Canyon Formation (N=5)
- Similar detrital signatures in both the Upper Member and Ash Canyon Member
- Peak ages: 94, 170, 1400, 1690 Ma
- Significant Mogollon contributions

Tres Hermanos Formation (N=2)
- Similar detrital signatures across field localities
- Peak ages: 95, 170, 1125, 1400, 1680 Ma
- Significant Mogollon contributions

Dakota Sandstone (N=2)
- Variable detrital signatures across field localities
- Peak ages: 104, 233, 410, 1048, 1405, 1731 Ma
- Significant Grenville contributions (elevated neoproterozoic ocurrences)



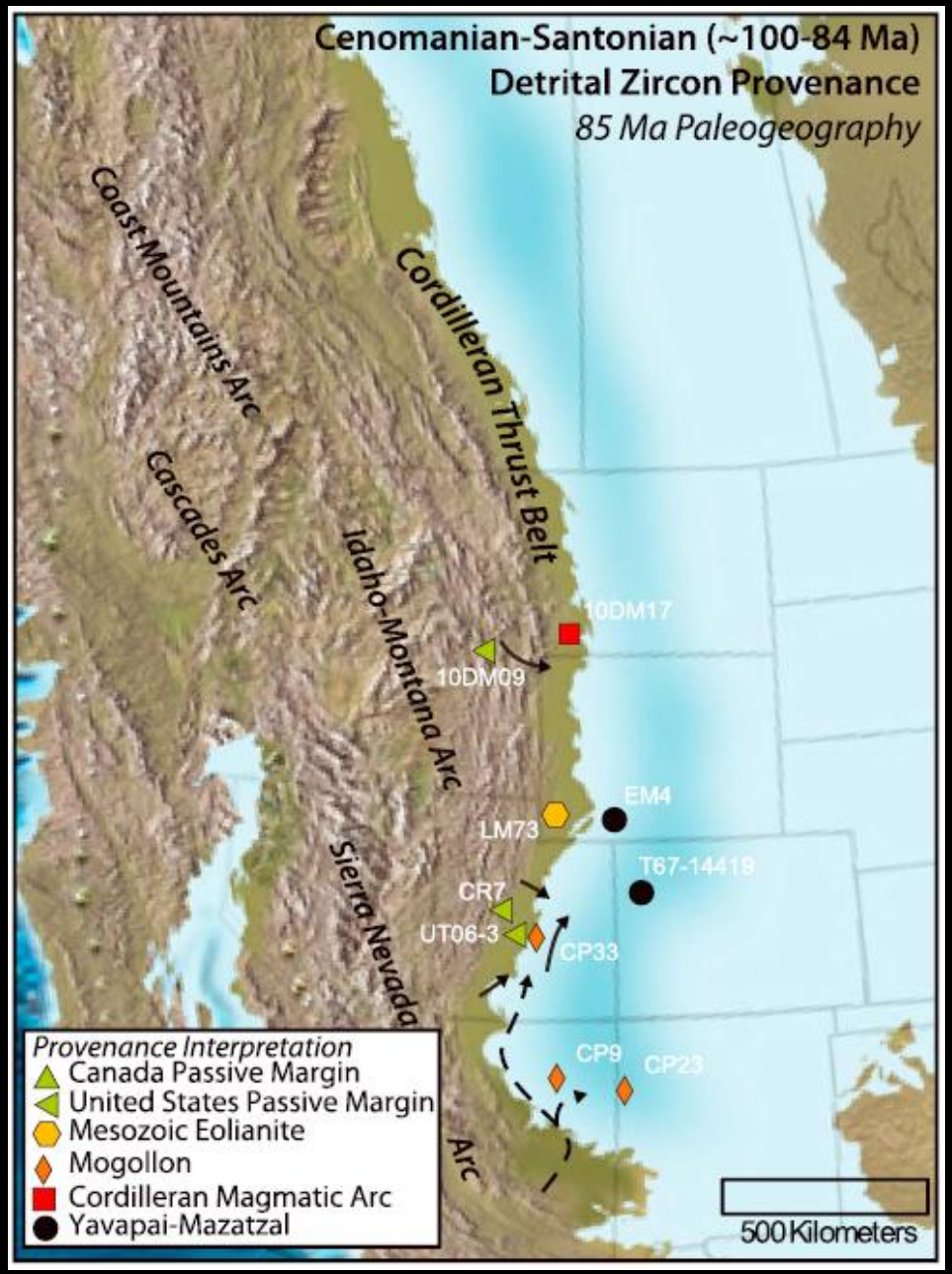
Modified from Lawton et al., 2014

SEDIMENT DISPERSAL SUMMARY

Crevasse Canyon Formation
- Paleoflow from west to east
- Primary contributions from Mongollon Highlands and Jr-K magmatic arcs

Tres Hermanos Formation
- Paleoflow from west to east
- Primary contributions from Mongollon Highlands and Jr-K magmatic arcs

Dakota Sandstone
- Paleoflow from west to east; south to north
- Primary contributions from Grenville Province and Tr and K magmatic arcs; neoproterozoic



Laskowski et al., 2013

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THANK YOU! - QUESTIONS?