Sandstone Composition Variation in Regressive to Transgressive Cycles in the Telegraph Creek and Eagle Formations in South-Central Montana

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ABSTRACT

The Upper Cretaceous Telegraph Creek and Eagle formations in south-central Montana contain a series of regressive to transgressive cycles deposited on the western margin of the Cretaceous Interior Seaway. This study focuses on sandstone mineralogy/provenance and sandstone clay composition. Four cycles have been identified and mapped regionally using outcrop and subsurface data. Each cycle left behind an upward- coarsening shoreface and/or deltaic sandstone body, capped by either a transgressive sand, an erosional top or maximum flooding surface. Each successive cycle stepped further basinward creating a larger progradational wedge. The lowest cycle studied, the Telegraph Creek Formation, contains a single regressive sandstone topped by a transgressive ravinement surface and pebble lag. Petrographic composition modes average Qt/F/L 54/25/21 and clay content is primarily Fe chlorite and berthierine. The Eagle Formation is composed of three cycles. The basal cycle is a detached low-stand delta capped by a ravinement surface, which is overlain by transgressive “green” marine sands. The regressive delta sandstones average Qt/F/L 59/17/24 and clays present are dominantly Fe chlorite and berthierine. The “green” sands are Qt/F/L 68/11/21 and the clays primarily smectite, Fe chlorite and glauconite. The middle cycle is a highstand normal regressive delta and a sharp-based forced regressive shoreface that are incised into. This is indicative of base- level fall and the incision surface represents a sequence boundary. The delta sandstones are Qt/F/L 66/17/17 and clays dominantly Fe chlorite and berthierine. The shoreface Qt/F/L is 68/17/15 and clays are primarily kaolinite and Fe chlorite. This is transgressed by a tidally-influenced valley- fill, shoreface, and marine “green” sand. The valley fill is Qt/F/L 73/14/13 with clays primarily kaolinite and Fe chlorite in the lower part. Smectite and glauconite become abundant in the upper part. The shoreface is Qt/F/L 68/15/17 with clays primarily smectite, Fe chlorite, and glauconite. The “green” sand is Qt/F/L 70/10/20 and clays are primarily smectite and glauconite. The top cycle is normal regressive shoreface and delta deposits capped by a transgressive ravinement surface with a black chert-pebble lag, representing the Claggett transgression. The delta deposits are Qt/F/L 72/13/15 and the shoreface is Qt/F/L 81/8/11. Clays in this cycle are dominantly Fe chlorite and berthierine. Petrographic data indicate that all cycles are sourced from a recycled orogen setting with a trend of increasing quartz content up-section. Potassium to plagioclase feldspar ratios are ~1 to 1 in the Telegraph Creek, basal Eagle cycle, and the incised valley fill/transgressive shoreface part of the middle Eagle cycle; otherwise the ratios are ~2 to 1. The lower ratios are coincident with the presence of bentonite beds, indicating active volcanism. The dominate clays in regressive sandstones represent a verdine facies (Fe chlorite ~35% and berthierine ~25%) indicating deposition in a shallow warm- water nearshore setting with substantial fresh water input. Transgressive clays are dominated by smectite (~25%), Fe chlorite (~20%), and glauconite (~15%), similar to a glaucony facies suggesting a dominance of marine shelf processes. The preponderance of kaolinite (~30%) in forced regression shoreface and valley fill sediments is thought to be the result of delta plain incision.
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