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River patterns reveal two stages of landscape evolution at an oblique convergent margin, Marlborough Fault System, New Zealand

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S1 – Study Area Geology

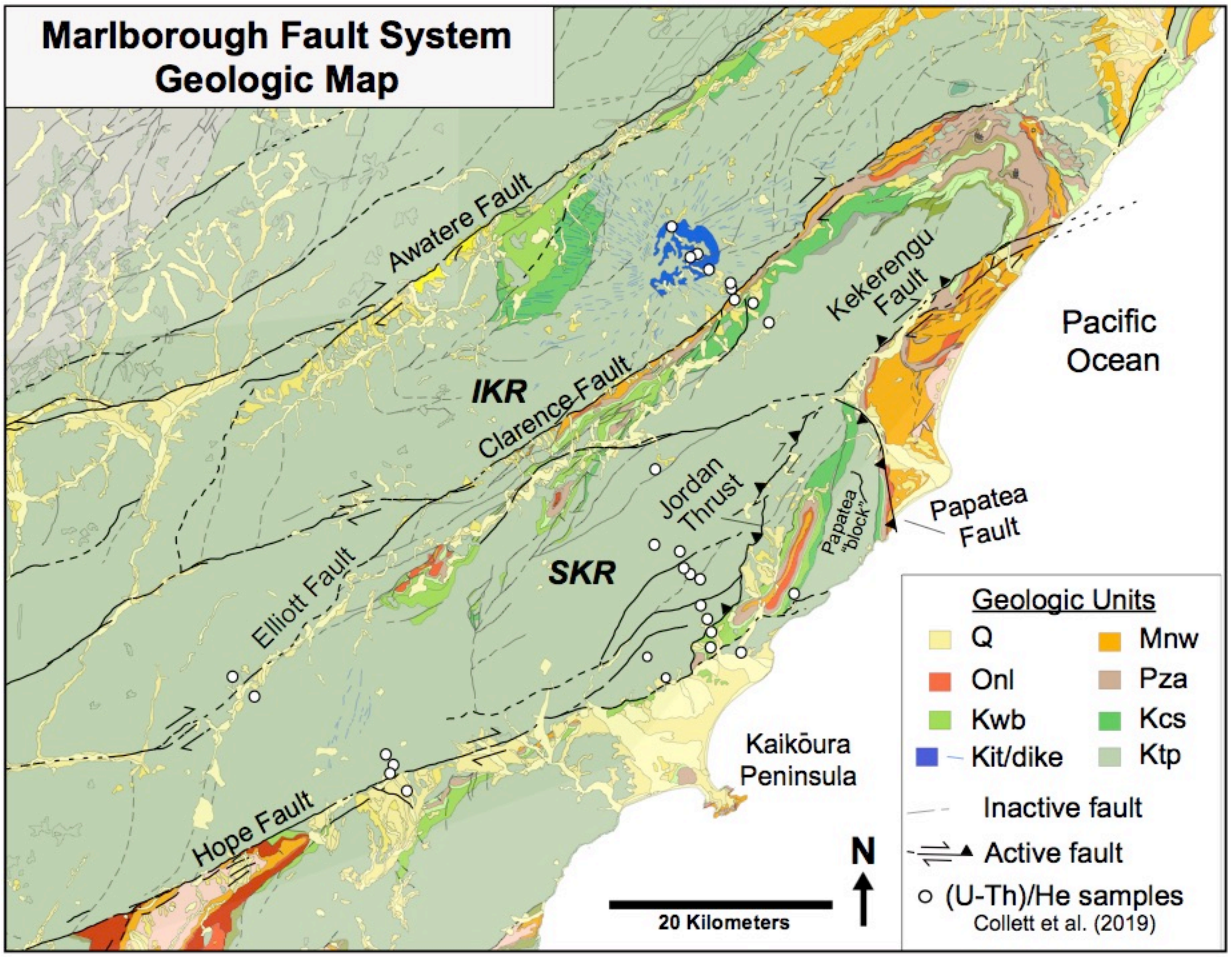

Figure S1: Geologic map of study area (Rattenbury et al., 2006) with thermochronology sample locations (white circles) and inactive (gray) and active (black) faults. Geologic Units: Quaternary deposits (Q), Miocene Waima Formation mudstone and conglomerate (Mnw), Oligocene limestone (Onl), Paleogene Amuri limestone (Pza), Cretaceous Bluff sandstone (Kwb), Cretaceous Split Rock sandstone (Kcs), Cretaceous Tapuaenuku igneous complex (Kit), Cretaceous dikes (blue lines) andn Cretaceous Torlesse Pahau terrane sandstone and mudstone (Ktp). IKR – Inland Kaikōura Range, SKR – Seaward Kaikōura. Figure adapted from Collett et al. (2019).

S2 – Awatere and Clarence River Longitudinal Profiles, Manual Designation

We made longitudinal river profile plots showing distance vs. elevation for the main Awatere and Clarence rivers (Fig. 5) using the TAK KsnProfiler functionality (Forte and Whipple, 2019). These river segments were designated manually based on breaks in slope on χ-elevation plots (Perron and Royden, 2013) shown below in Figs. S2 (Awatere river) and S3 (Clarence river).

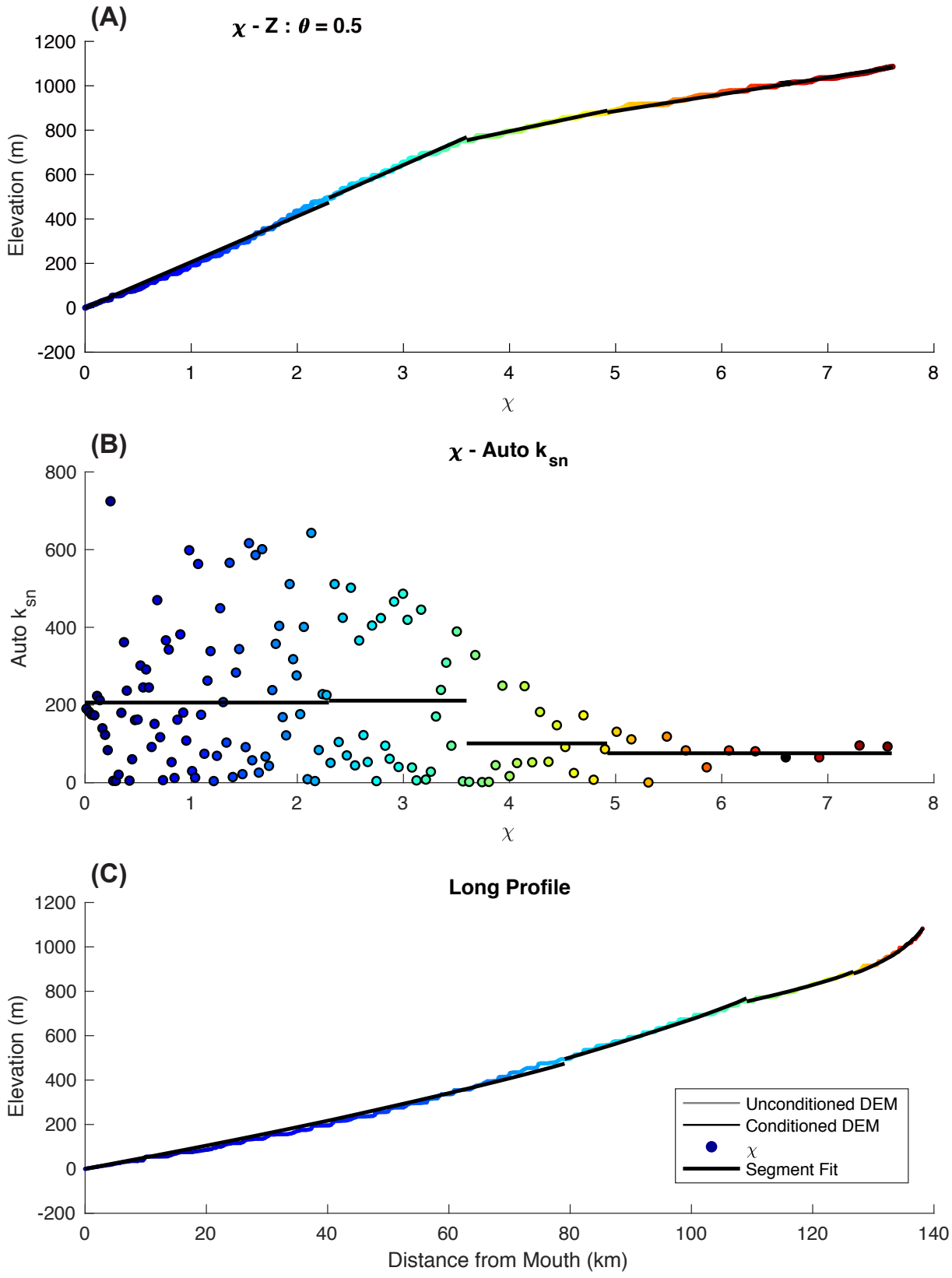
(A)
χ - Z : θ = 0.5
Elevation (m)
χ
(B)
χ - Auto k_sn
Auto k_sn
χ
(C)
Long Profile
Elevation (m)
Distance from Mouth (km)
Unconditioned DEM
Conditioned DEM
χ
Segment Fit

Figure S2: Awatere river profile analysis plots. Output generated from the Topographic Analysis Kit (TAK – Forte and Whipple (2019)), k_{sn} Profiler function. (a) χ – elevation plot (concavity, $\theta = 0.5$) with manually chosen river segments shown in black. (b) χ – auto k_{sn} plot with river segments shown in black. (c) longitudinal channel profile: distance from mouth – elevation plot with river segments shown in black.

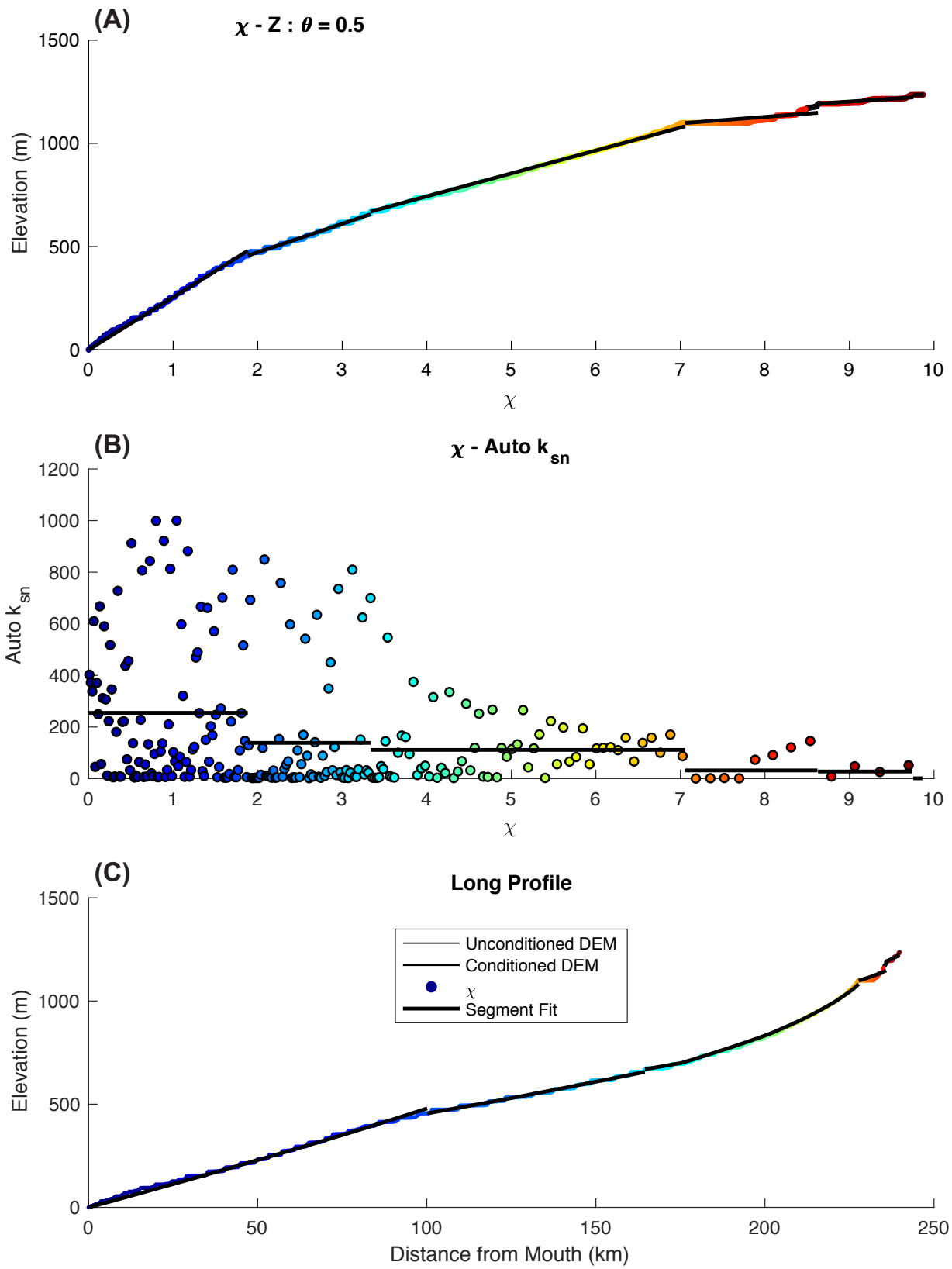

Figure S3: Clarence river profile analysis plots. Output generated from the Topographic Analysis Kit (TAK – Forte and Whipple (2019)), k_{sn} Profiler function. (a) χ – elevation plot (concavity, $\theta = 0.5$) with manually chosen river segments shown

in black. (b) χ – auto k_{sn} plot with river segments shown in black. (c) longitudinal channel profile: distance from mouth – elevation plot with river segments shown in black.