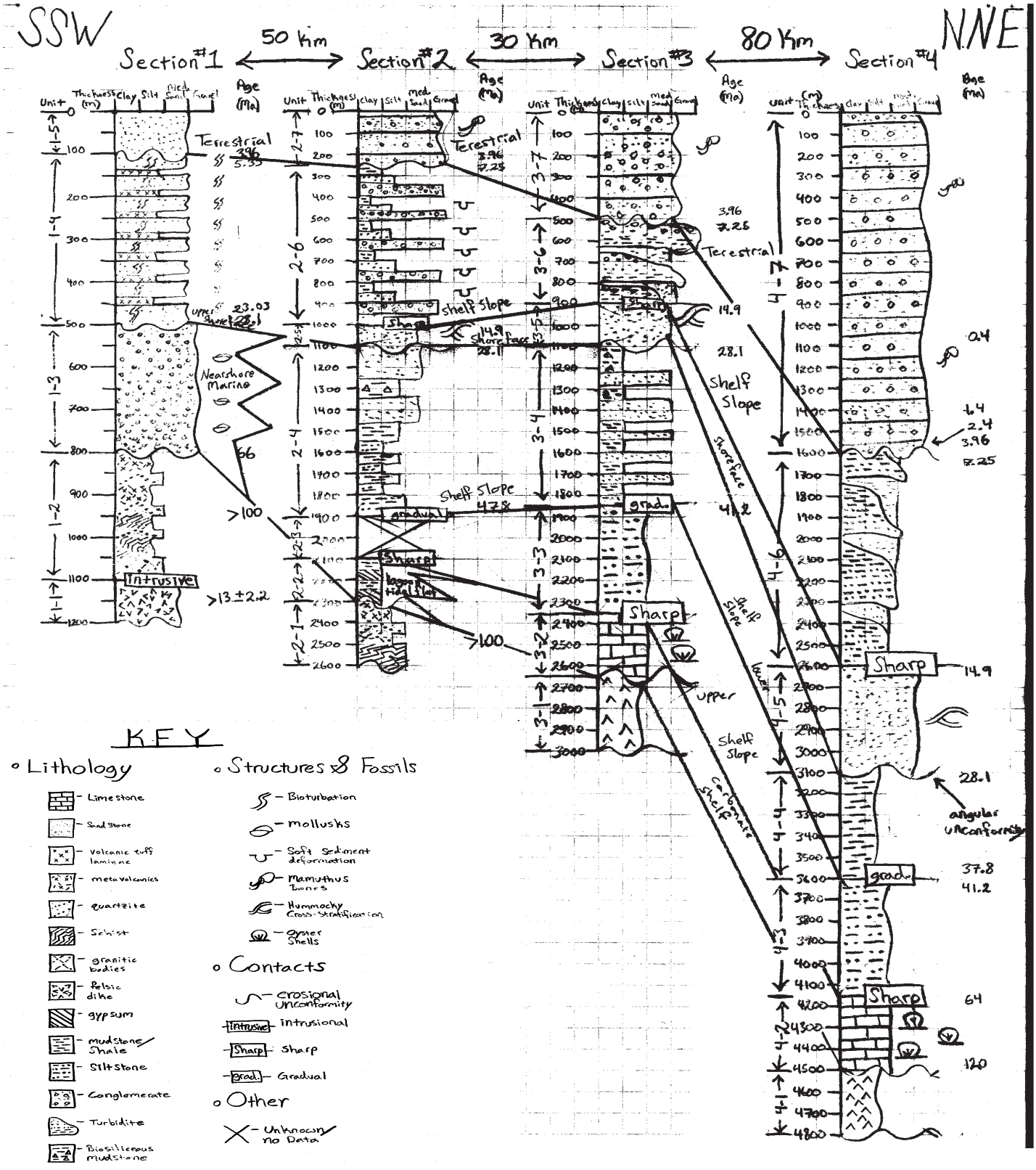
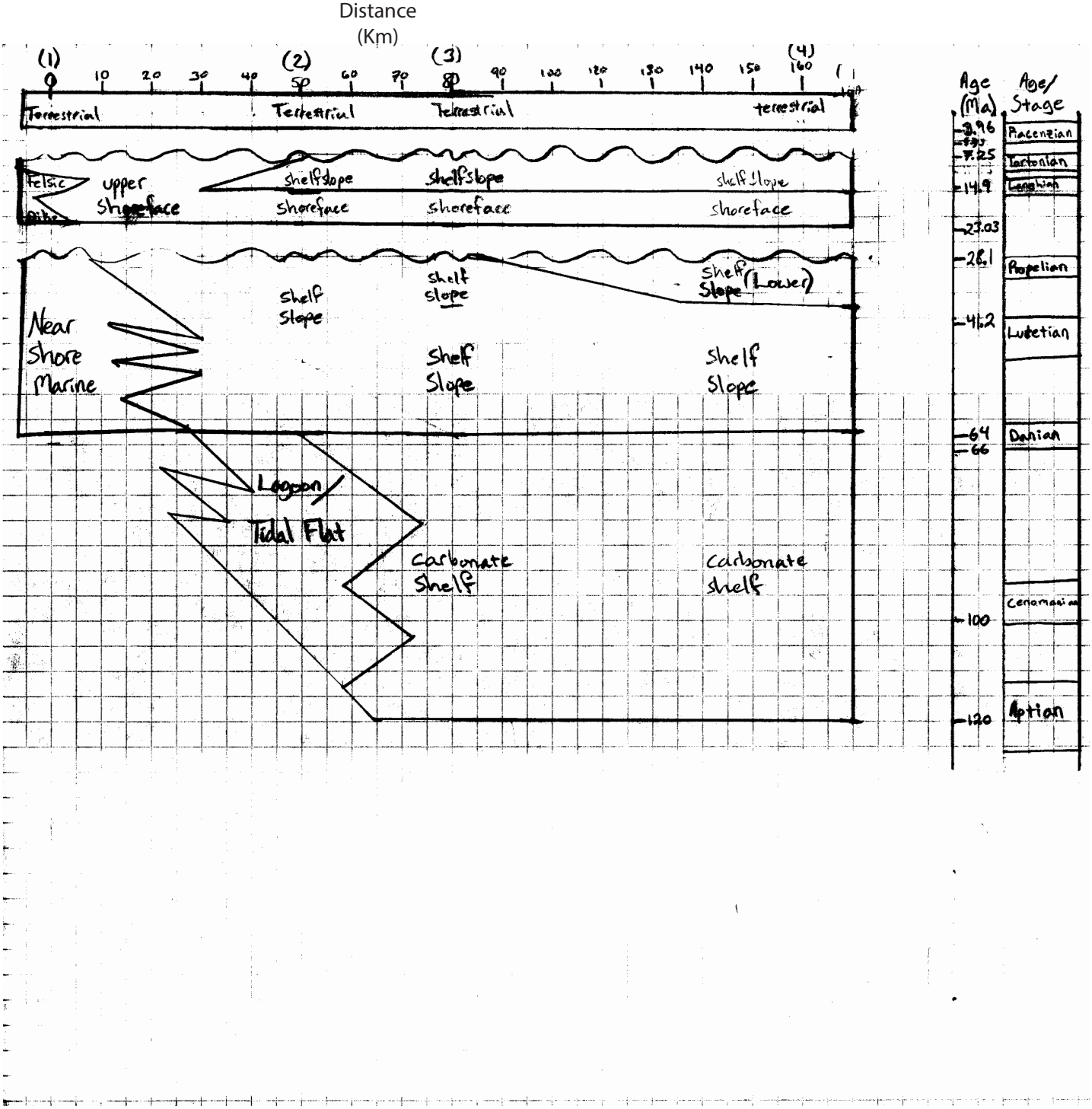
Final Report: Basin Analysis

By Andrew

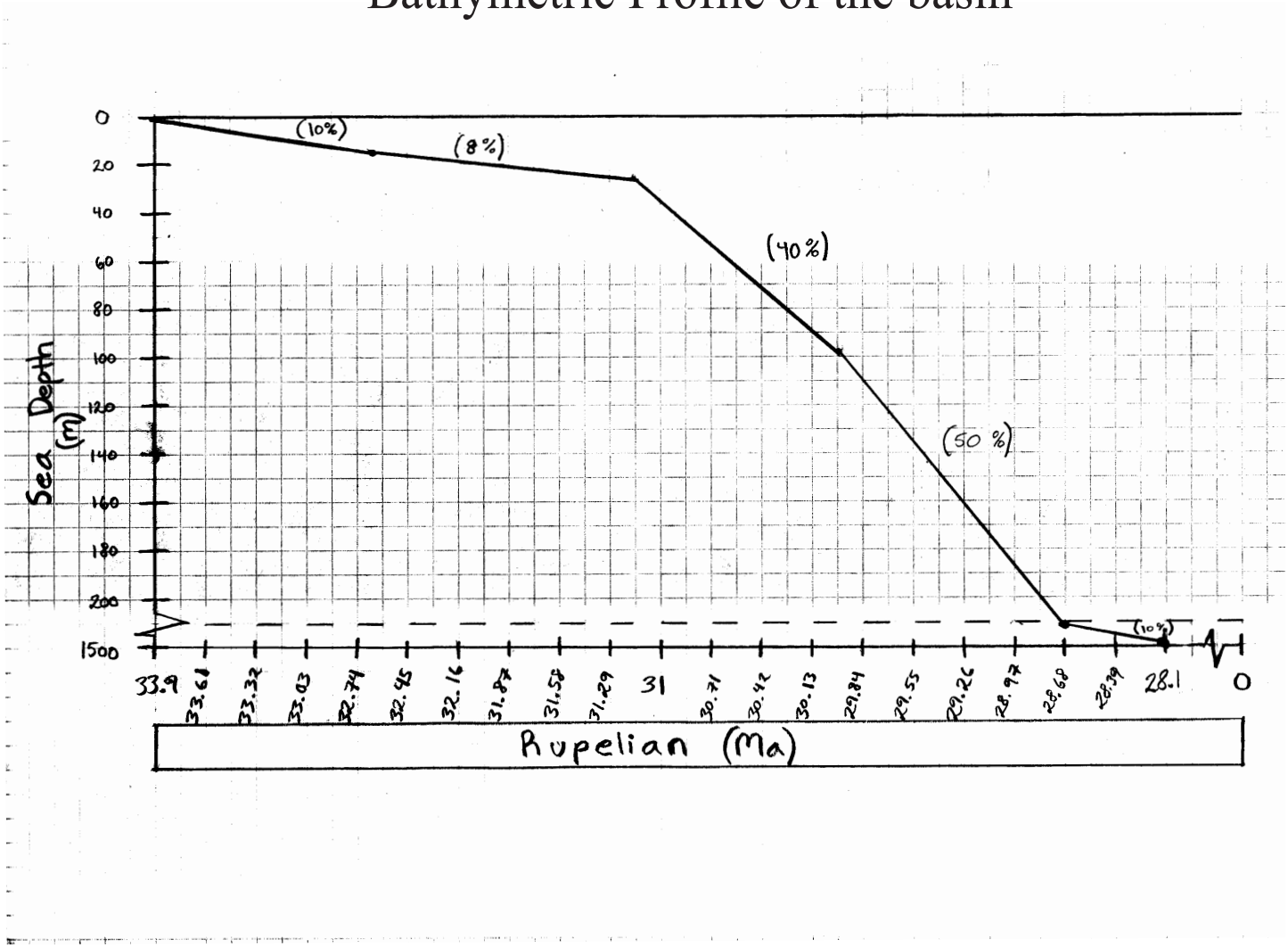
Lithostratigraphic Cross-Section



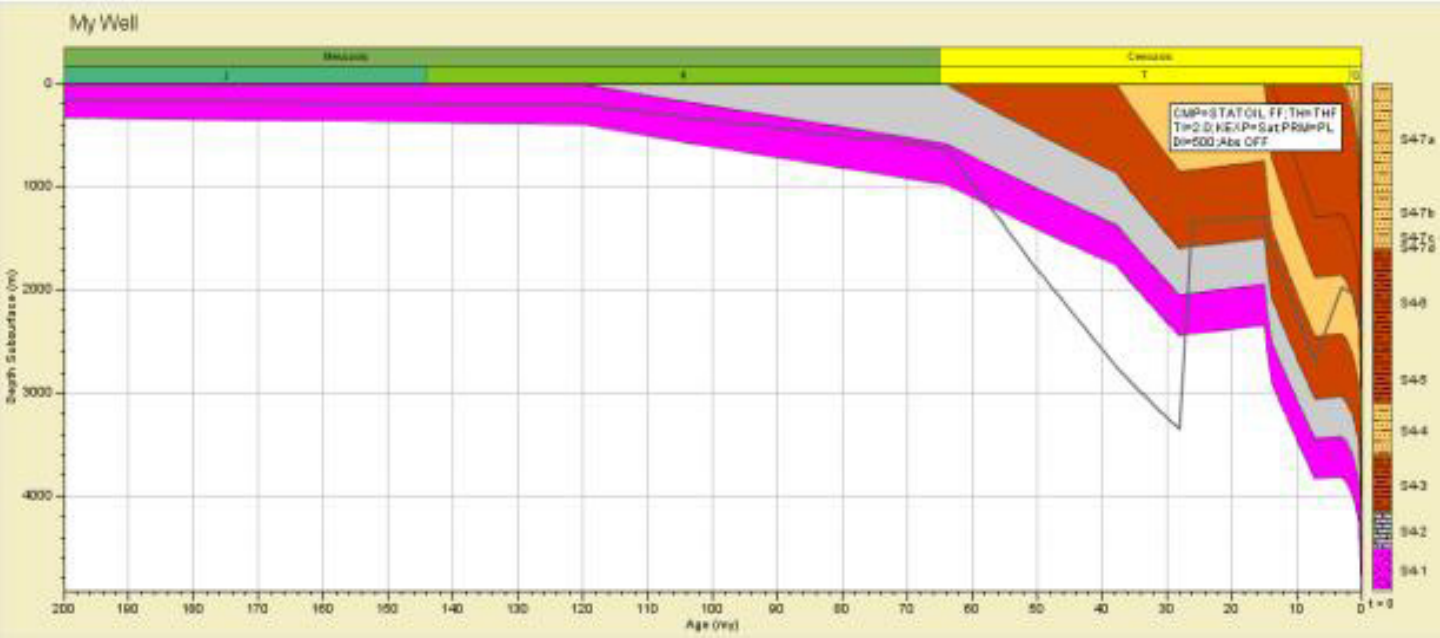
Chronostratigraphic Section



Bathymetric Profile of the basin

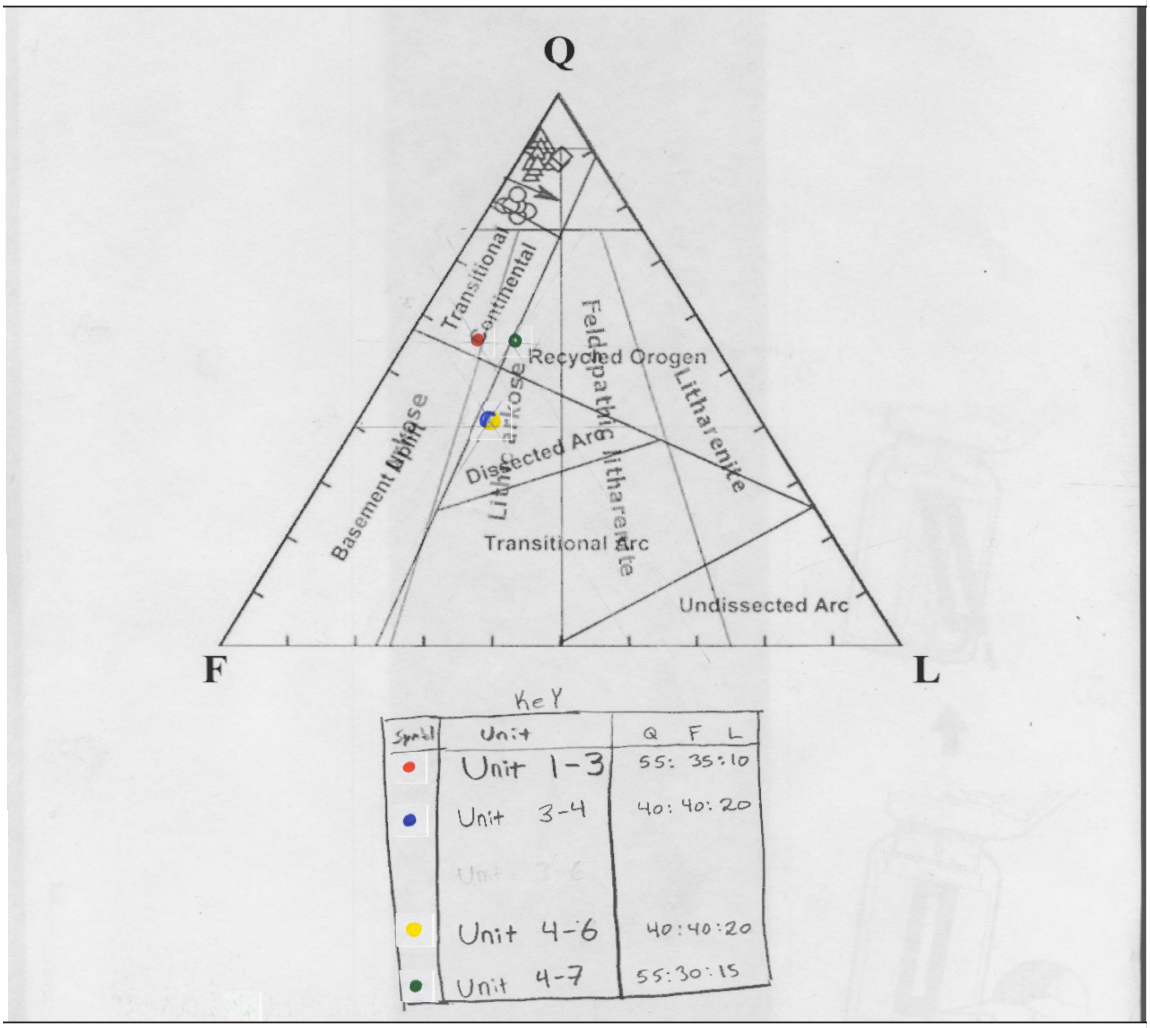


BasinMod Geohistory Model



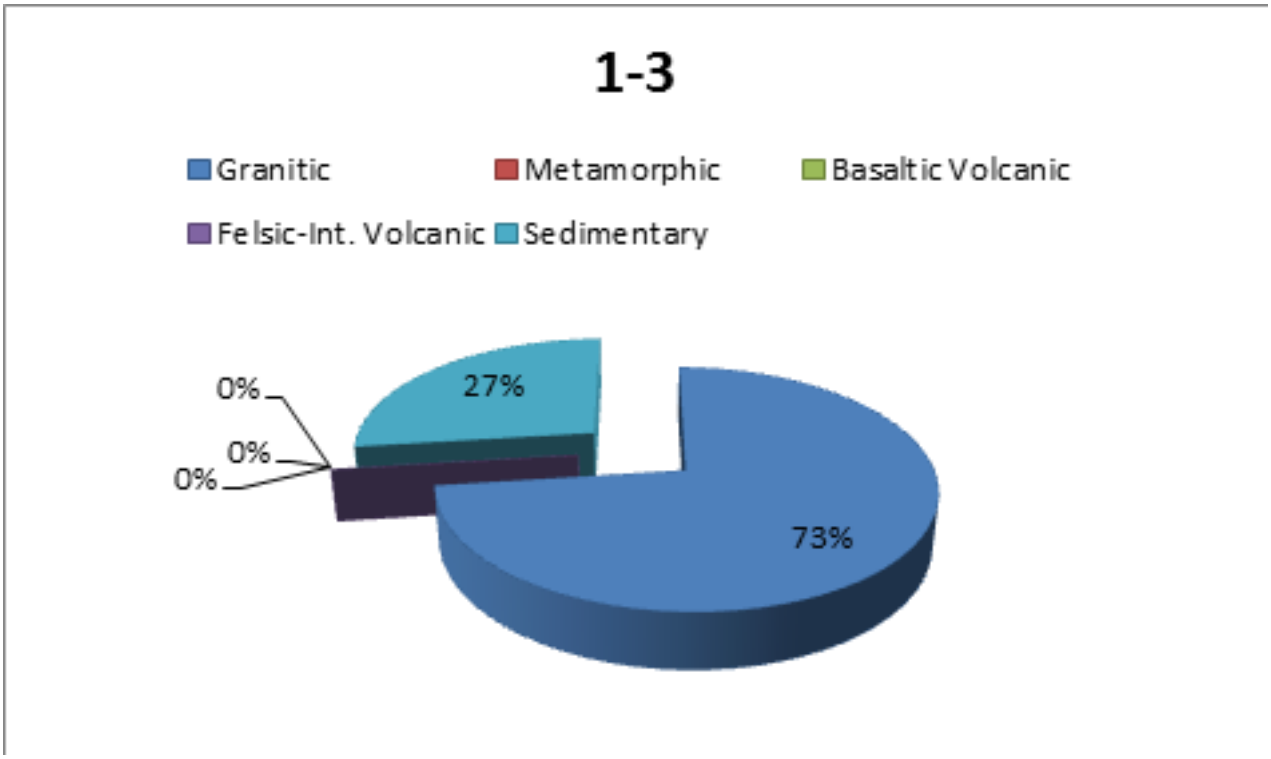
The geometry of the tectonic subsidence curve over time is indicative of a foreland basin Xie & Heller (2009). This is because of the convex shape and the frequent episodic subsidence events. In the section the base of igneous is likely making a volcanic arc setting. The section trends to deeper and quieter energy environments as inferred from the sediments, however, moving up section the sediments coarsen.

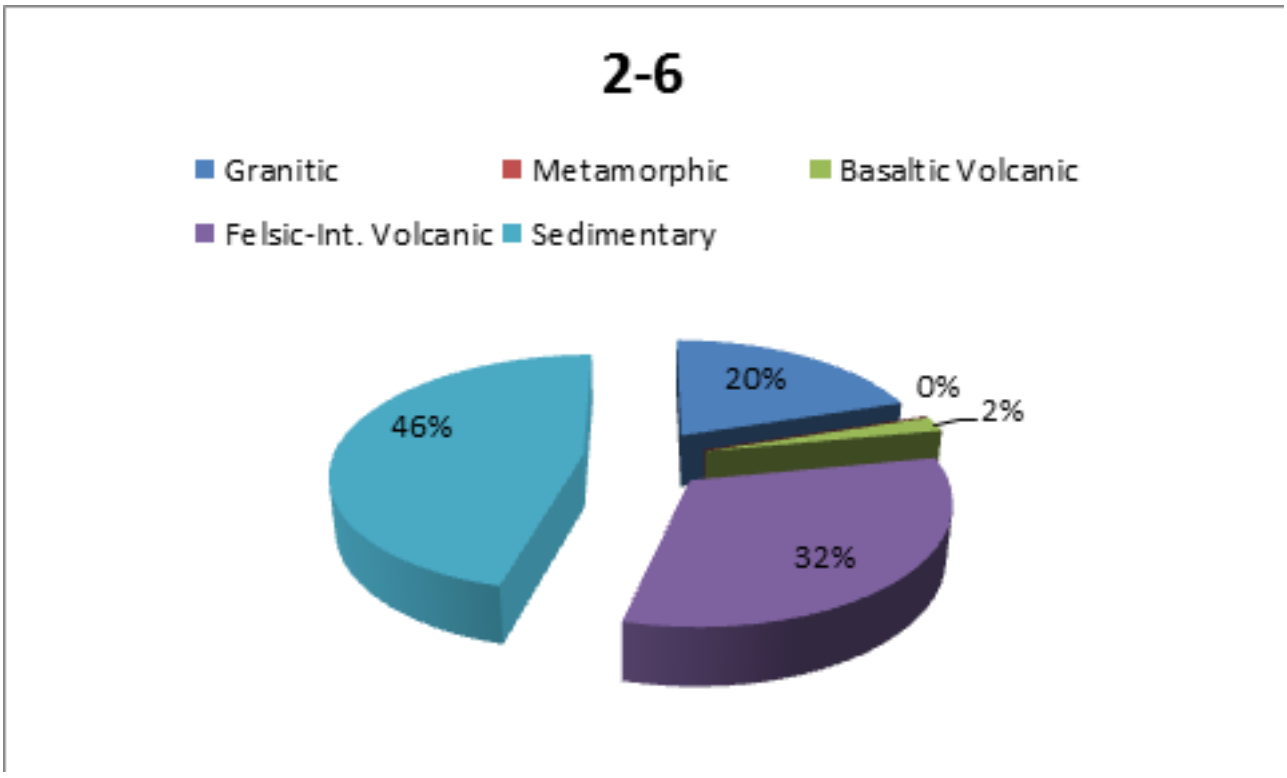
QFL Diagram

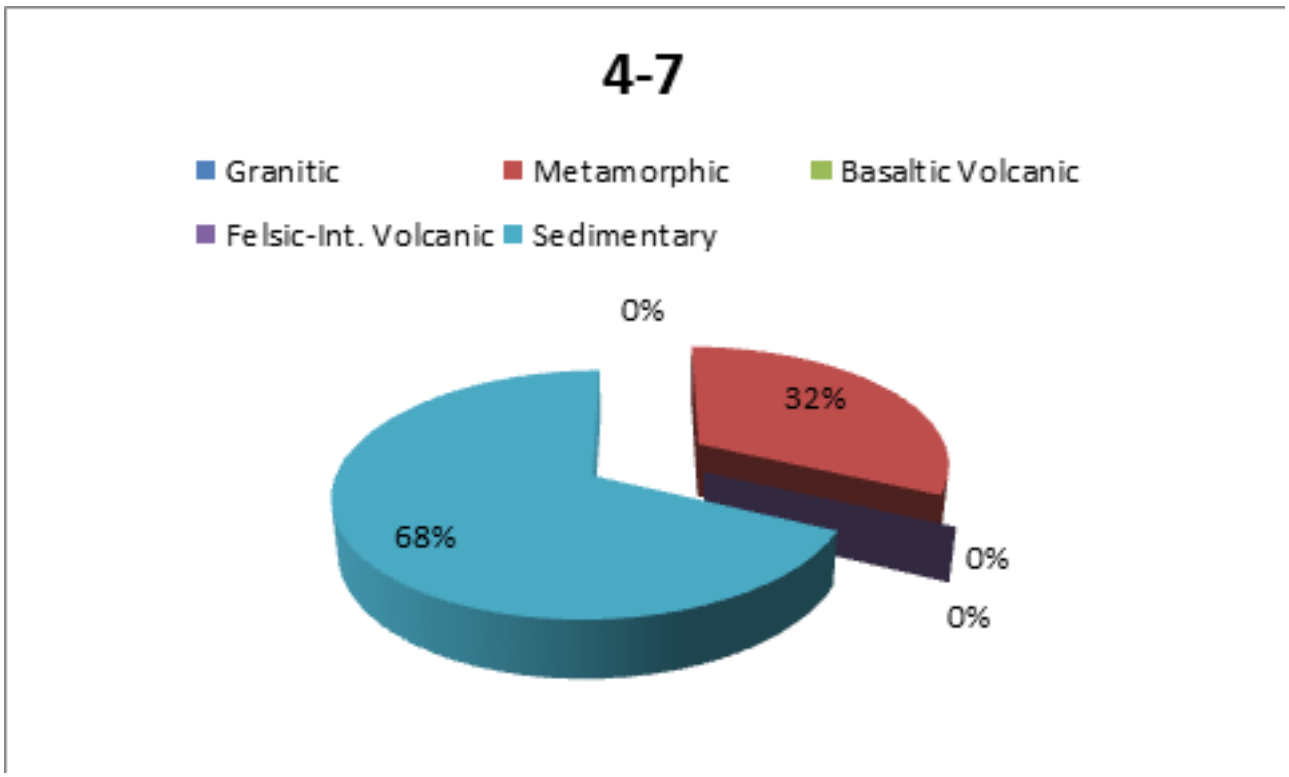


The QFL diagram gives tectonic settings, as well as rock composition for units 1-3, 3-4, 4-6 and 4-7. Unit 1-3 plots as a transitional continental setting. Units 3-4 and 4-6 plot as dissected arc settings, and unit 4-7 plots as recycled orogenic. Compositionally the units are all very similar with Unit 1-3 being the most mature because of its high quartz and low lithics content. Useful petrographic data would resolve ambiguities would be the composition of the lithics.

Gravel Counts







The gravel counts complement the QFL data because they resolve the above question about the composition of the lithic fragments. While the QFL data shows the units to be similar as far as the quartz, feldspar and lithic composition, the gravel data shows the samples to be drastically different in their lithic makeup.

For example, unit 1-3 is composed of 73% granitic and 27% sedimentary fragments whereas, Unit 4-7 is composed of 32% metamorphic and 68 % sedimentary fragments. Because of the large amount of granitic fragments it can be assumed that unit 1-3 is located in close relation to a volcanic arc. The lack of volcanic material in unit 4-7 shows that it is likely not in close relation to a volcanic arc. However, the metamorphics would indicate that it was deposited after large amounts of erosion down to the metamorphic rocks that may have underlain a volcanic arc. The metamorphics are a good indication of past orogenic events. Interestingly unit 2-6 is composed of mainly sedimentary fragments, with the rest being volcanic (primarily intrusive). Unit 2-6 was likely derived from a volcanic arc.

Unconformities

Prominent features of the stratigraphic section are the unconformities between Units 4-4 and 4-5 and between 4-6 and 4-7. These unconformities span 160 kilometers in length across all four sections. They are ancient erosional features that can be assumed to be above sea level. They were likely caused by changes in eustatic sea level or tectonic uplift, and good evidence for this can be seen between Units 4-4 and 4-5 because the unconformity is angular meaning Unit 4-4 has a dip.

Geological History of the Basin

The basin consists of four sections spanning 180 km from SSE to NNW. Section #1 is furthest SSE and moving up in numerical order Section #4 is the furthest NNW. Greater than 120 Ma the rock record shows igneous and metamorphics indicating that the rocks were below a volcanic arc where igneous intrusions were penetrating metamorphics. Moving NNW Section #2 was composed of a felsic dike, which would have been slightly closer to the surface but still near volcanism from an arc system. Section #3 shows basaltic rocks which extrusive igneous rocks are indicating we have reached the surface. Section #4 shows basaltic rocks as well. Topography drops nearer to sea level from SSE to NNW.

Around 120 Ma there is a section wide unconformity which could be due to tectonics or changes in eustatic sea level (likely influenced by both).

Evidence from gypsum interceded with mudstone implies that section #2 has transitioned into a lagoon or a tidal flat environment. Section #3 and #4 have dropped below sea level into the photic zone and are now in a carbonate shelf environment. Topography is continuing to drop from high to low from SSE to NNW.

A sharp contact around 64 Ma shows the transition to the sea for section #2 into the upper shelf slope. Sections #3 and #4 have transitioned into the shelf slope environment (lower to the NNW). This is indicative of a lower energy environment from the presence of siltstones and mudstones.

At 66 Ma section #1 enters the near shore marine environment and the rock record shows shallow marine mollusks. QFL data from unit 1-3 shows that lithics are still primarily composed of granitic rocks indicating that the source of volcanism (volcanic arc) is still in close proximity. The basin is forming, and increasing amounts of accommodation space is opening up moving from SSE to NNW.

The bathymetric profile of the basin during the Rupelian Stage, from 33.9 Ma to 28.1 Ma shows rapid changes in sea depth. The basin moves from deep abyssal and shelf slope environments back to shelf slope and near seal level depths at the SSE. Then at 28.1 Ma there is a section wide unconformity. The unconformity between units 4-4 and 4-5 are angular implying that unit 4-4 has a dip. This is evidence for tectonic uplift which supports the section wide erosional unconformity.

Around 23.03 Ma Section #1 has dropped below sea level and is in the upper shore face facies. The rock record shows bioturbated sand stone with interbeded volcanic tuff laminae. Section #1 is near enough to volcanism that fine particulates are being deposited.

Sections #2, #3 and #4 are in the shoreface environment up till 14.9 Ma. Hummocky cross stratification in sandstone is evidence for this environment because it is only found in a small window of the shoreface. Moving NNE unit 2-6 has entered the shelf slope environment and contains soft sediment deformation, as well as mass wasting features which are likely signs of ancient turbidities. Turbidites are strong evidence for active seismicity and can be triggered by tectonic events. Turbidites are occurring as larger events moving NNE. From 7.25 Ma to 3.96 Ma there is a large section wide erosional unconformity. This fall in eustatic sea level transitions all sections from marine environment to terrestrial. Uplift must have occurred more in the NNE. The 2D seismic-reflection line acquired from the area between Section#3 and Section #4 (from Final Assignment) shows that regional sediment transport has transitioned from SSW to NNE, to the more recent transport of sediments from the topographic highs in the NNE to the topographic lows in the SSW. This is supported by larger grain sizes moving NNE (transition from sands to conglomerates) as well as Mammoth bones and in the furthest section to the NNE, Section #4 you get coalified plant material.

In conclusion the rock record shows early volcanism and an island arc tectonic setting which created a foreland basin and then transitioned to a passive margin.