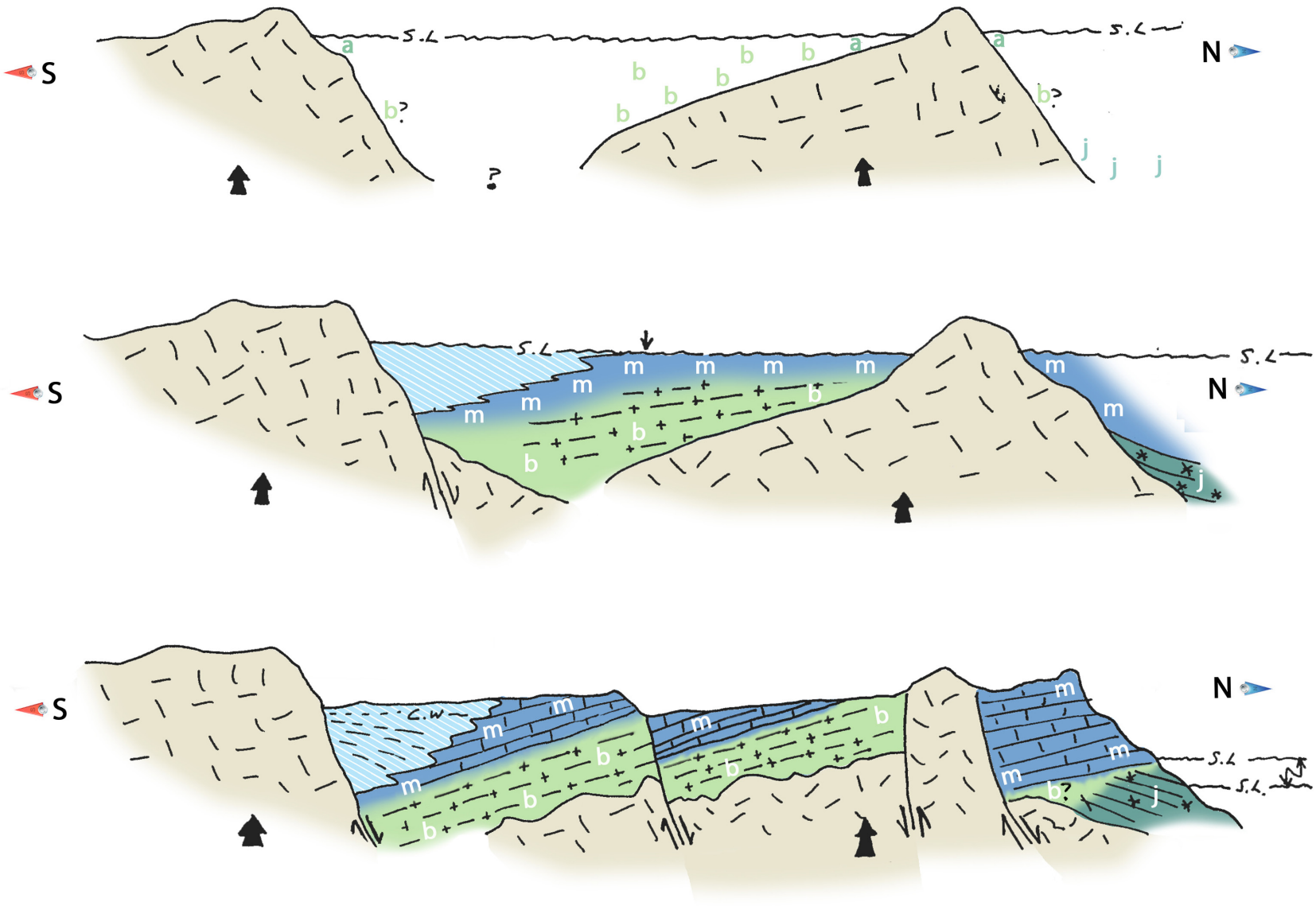
EVOLUTION OF NORTHERN GUAM LIMESTONE AQUIFER



Miocene-Pliocene: Barrigada Limestone (b) deposited as carbonate periplatform facies on emerging volcanic high, separated from southern Guam volcanic terrain by deeper water. Barrigada Limestone is time equivalent to reefal Alifan (a) and pelagic Janum Limestones (j). Youngest Barrigada sediment indicates shoaling and near reef conditions. No emergence of Barrigada Limestone above sea level before Mariana Limestone was deposited.

Pliocene-Pleistocene: Mariana Limestone (m) deposited directly atop Barrigada sediments as carbonate bank shallowed to almost-atoll configuration (reefs, lagoons, volcanic islands). At least 175 m of very shallow-water facies indicates basinal subsidence in balance with arc emergence. Uplift along Adelup-Pago Point Fault promoted erosion and clastic wedge (CW) of volcanics in southern Mariana basin.

Pleistocene-Holocene: Sea level fluctuations of perhaps 85 m and continued arc emergence produce multiple terracing and progressively younger perimeter reefs. Faulting and tilting of northern Guam limestone section continued through Miocene-Pleistocene. Uplift of island and sea level swings produce major changes in geometry of freshwater lens system. Limestone section underwent pervasive diagenesis, reacting to as many as four different geochemical environments: marine phreatic, mixing, freshwater phreatic, and vadose. Mineralogy completely stabilized to calcite; secondary porosity and cements formed, karstification underway.

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m	Mariana Limestone		Hagatña Argillaceous Member	a	Alifan Limestone
j	Janum Formation	b	Barrigada Limestone		Alutom Formation

PETROGRAPHIC SUMMARY OF NORTHERN GUAM LIMESTONE AQUIFER

	Barrigada Limestone	Mariana Limestone	Hagatña Member
Depositional environment	Emerging, eventually shoaling, bank of ramp, isolated from terrigenous source, mainly below wave base	Almost atoll with barrier reef system semi-encircling emerging Barrigada bank; sedimentation shifts seaward with emergence	Southern part of basin: faulting of volcanics produce terrigenous wedge into carbonate environments
Facies	Generally non-reefal, periplatform, grading upward to reef front	Lagoonal, reef margin, reef front, forereef	Lagoon, reef flats, tidal flats and channels, patch reefs
Water depths	~ 15 - 175 m	~ sea level to 30 m	~ sea level to 15 m
Principal biogenic elements	Benthic foraminifera and red algae	Reef corals, red algae, calcareous green algae, molluscs	Corals, molluscs, red algae
Primary texture	Fairly well sorted wackestone-packstone, coarsening upward in section to scattered rudstones	Poorly to non-sorted packstones, grainstones, rudstones and boundstones	Poorly to non-sorted packstones and rudstones
Primary mineral composition	Mg-calcite	Aragonite	Aragonite, volcanics, clay
Probable primary porosity / flow	Intergranular / Diffuse	Intergranular and intragranular / Diffuse and conduits	Intergranular and intragranular / Diffuse
Secondary texture	Fairly well sorted, massive to friable to powdery packstones and wackestones	Poorly to non-sorted, often cavernous packstones, rudstones and boundstones	Poorly to non-sorted packstones, rudstones
Secondary mineral composition	Calcite	Calcite	Calcite and clay
Secondary porosity	Moldic, intergranular, cavernous, fracture	Cavernous, moldic, intergranular, fracture	Moldic, cavernous, intergranular, fracture
Trace element loss/gain	Mg/Fe, Mn	Sr/Fe, Mn	

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