

Geological History of Guam: Limestone Deposition

BI 201 Natural History of Guam
Class Presentation 14

Limestone Construction of Guam

A. Deposition of the **Bonya Limestone Formation**

- The Bonya (or Boña) Limestone was deposited while Guam was part of the West Mariana Ridge
- It overlies Umatac volcanics, i.e., Bolanos Member, immediately north of Fena Lake and in the Ylig and Talofoyo river valleys
- There are also small exposures along the NW coast near Janum Pt.

- The age of Bonya Limestone is Miocene, 11–8 Mybp
- The maximum thickness is 15 m, but it averages no more than 10 m
- Bonya Limestone consists of skeletons of deepwater and shallow-water organisms

B. Deposition of the **Alifan Limestone Formation**

- Alifan Limestone overlies Bonya Limestone in the Ylig and Talofofu valleys, but it sits directly upon Alutom volcanics in the Naval Magazine area
- Alifan limestones are distributed on the ridge crest from the top of Mt. Lamlam to the top of Mt. Alifan

- It is also found as a fringe of limestone around Mt. Santa Rosa and Mataguac Hill
- Alifan Limestone caps the highest parts of Guam
- This evidence indicates that Guam was submerged following rifting from the West Mariana Ridge

- Alifan Limestone was probably deposited in a shallow lagoon between the Mt. Alutom area and a “southern island” [i.e., there were at least two centers of volcanism during the Umatac volcanic episodes]
 - Evidence for the “southern island” is the clay contamination in limestones in southern Guam

- Because Alifan Limestone caps the highest elevations on Guam, it was probably deposited after the island rifted away from the West Mariana Ridge
- The age of the Alifan is late Miocene, ca. 5–10 Mybp
- Its maximum thickness is 45 m

- Alifan Limestone consists of shallow-water lagoon and reef deposits
- The oldest portion of the Alifan is the Talisay Member
 - Named for the Talisay River, where it was first discovered, Talisay Limestone represents probably the earliest evidence of a terrestrial environment in Guam and the Mariana Arc

- Erosion has removed almost all of the Alifan today
 - Alifan limestones are exposed intermittently along the west central coast, between Apra Harbor and Agana, east of Marine Drive at elevations of 10–50 m

C. Deposition of the **Janum Limestone Formation**

- The Janum Limestone is the most geographically restricted Miocene unit of Guam, cropping out only in small coves and slumps along the NE coast near Janum Pt.
- Janum Limestone is distinct lithologically from all other limestones in the Marianas

- The Janum Formation represents a deep forereef environment in its lower sections (grayish-white in color) to a basinal environment in upper sections (salmon-pink in color, i.e., from iron oxides)
 - The pink upper unit also contains an assortment of volcanic debris in sand to coarse-silt sizes, providing the earliest evidence of a terrestrial environment in the Mt. Santa Rosa-Mataguac Hill area

- The maximum thickness of the Janum Limestone is 20 m
- The age of Janum limestone ranges from 5–10.5 Mybp

D. Deposition of the **Barrigada Limestone Formation**

- The Barrigada Limestone underlies much of the northern plateau of Guam, where it outcrops in an atoll-like, annular configuration
- The Barrigada Formation was deposited during a period of tectonic uplift causing emergence of northern portions of Guam

- Deposition occurred during emergence of a deepwater bank area (up to 100 m) between Mt. Alutom and Mt. Santa Rosa, while the remainder of the island was being eroded
- Barrigada Limestone is usually dead-white, pure limestone
- The age of Barrigada Limestone is Miocene to Pliocene, 5–1.6 Mybp, depending upon whether it is a deepwater or shallow-water member of the formation]

- The maximum thickness of Barrigada Limestone is 540 ft
- Continued tectonic uplift of Guam brought Barrigada Limestone to the surface
- The upper contact of the Barrigada Formation with the Mariana Limestone Formation is variously transitional to abrupt

E. Deposition of the **Mariana Limestone Formation**

- The Mariana Limestone Formation is the last major deposition of limestone in the construction of Guam
- Mariana Limestone overlies the Barrigada Formation and covers most of the surface of the northern plateau

- It also forms a 1–2 km wide strip paralleling the SE coastline and comprises most of Orote Peninsula
- In some areas the Barrigada and Mariana limestones intergrade and are difficult to distinguish, e.g., at Cabras Island
 - Therefore, there must have been either a major submergence of the island or there has been a sea level rise
- The Mariana Formation was deposited during formation of Mariana Basin

- The age of the Mariana Formation is Pleistocene, 1.6 Mybp–10,000 ybp, a period characterized by frequent glaciation and fluctuation of sea level
- The maximum thickness of Mariana Limestone is up to 175 m

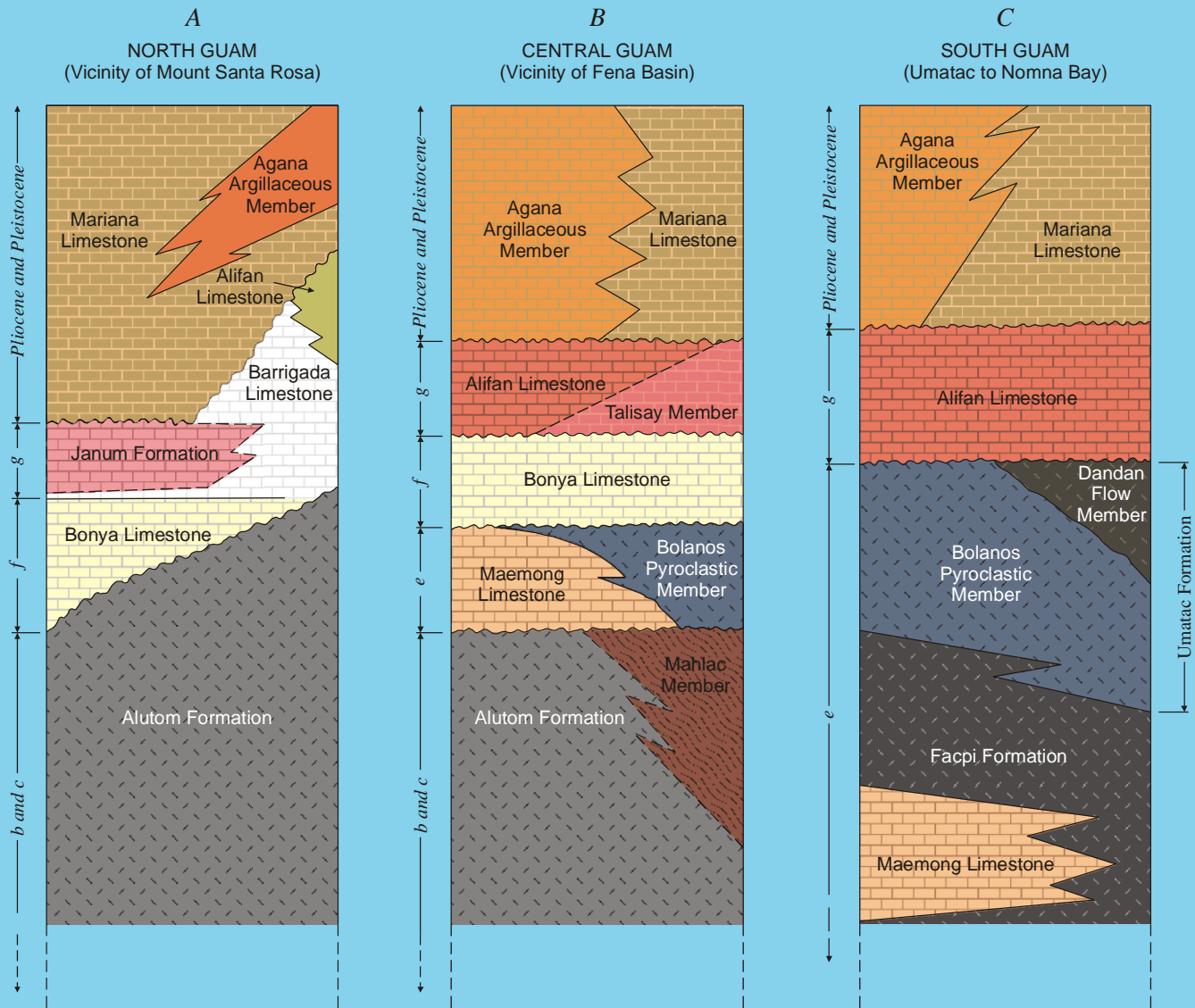
- About 1.4 Mybp, subduction resumed and lifted northern Guam up, raising Mt. Santa Rosa to about 600 ft elevation, but Merizo remained at 0 ft elevation, because the island faulted along the Adelup-Pago Fault line
 - Consequently, the island tips towards the southwest at about 25 ft/mile
 - During the faulting, Callalan Bank at western end of Luminao Reef dropped by faulting

F. Deposition of the **Merizo Limestone Formation**

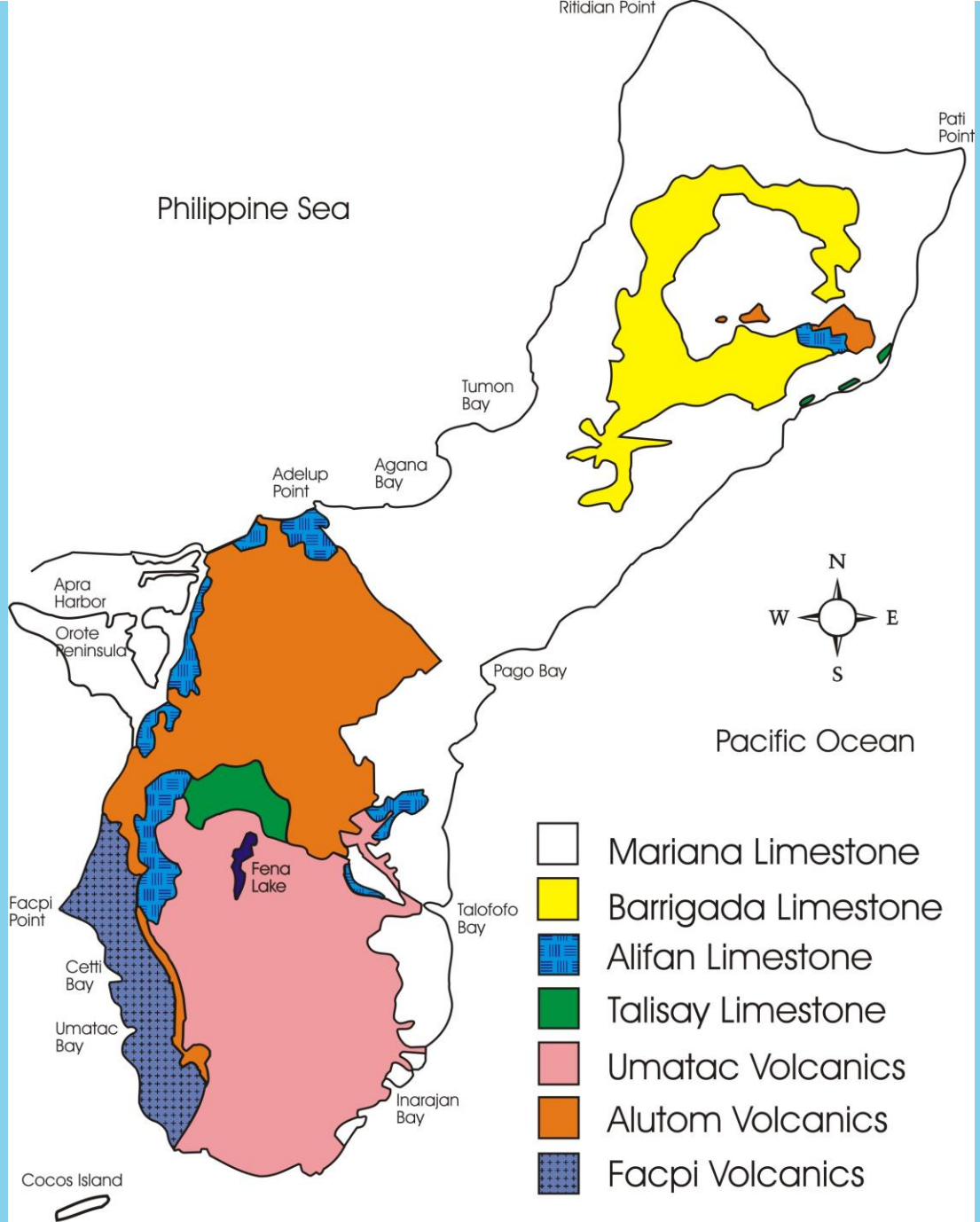
- The Merizo Formation is the current phase in construction of Guam
- The age of the Merizo Formation is Holocene, or about 5000–3000 yr

- The Merizo Limestone Formation is mostly argillaceous limestone because of erosion of the island during the limestone deposition
- Merizo Limestone is distinguished from Mariana Limestone by observing the degree of crystallization
 - Mariana Limestone is completely recrystallized into calcite and has a sparkling, glassy appearance

INDONESIAN FAUNAL ZONES (after van Bemmelen, 1949 p. 73r108)	UNITED STATES TERTIARY SERIES
	<i>Recent</i>
	<i>Pleistocene</i>
<i>h</i>	<i>Pliocene</i>
<i>g</i>	<i>Miocene</i>
<i>f</i>	
<i>e</i>	
<i>d</i>	<i>Oligocene</i>
<i>c</i>	
<i>b</i>	<i>Eocene</i>
<i>a</i>	



Columnar stratigraphic sections from north, central, and south Guam. Each diagrammatic section is a local composite of strata arranged to illustrate formational relationships and is not to true vertical scale. [Modified from Schlanger, 1964].



General Distribution of Surface Rocks on Guam