APPENDIX B

CAVE AND KARST INVENTORY:

MAPS AND DESCRIPTIONS

The following descriptions are listed in alphabetical order by the feature's name, in order to simplify locating information pertaining to a specific feature. Features on Tinian are summarized in Table 1 and features on Aguijan are summarized in Table 2. Each surveyed feature includes its physiographic location (Figure 1 and 2, Chapter II) with the description and approximate cave locations. All features were surveyed in accordance with the National Speleological Society's protocols (Dasher, 1994) and final maps drafted using the Association for Mexican Cave Studies (AMCS) symbology (Figure 10, Chapter III ; Sprouse and Russell, 1980).

"600 Meter" Fracture System (Southeastern Ridge, Tinian – Figure 40)

The "600 Meter" Fracture System is a high-angle fracture located approximately 500 meters west/northwest of Puntan Masalok in the Mariana Limestone (QTmu), where it trends northwest (~310^{o}) for over 300 meters before the feature becomes obscured by additional surface features and vegetation, however topographic maps for the island confirm that it extends for approximately 600 meters (United States Department of the Interior Geological Survey, 1983). Full Bottle Cave is located in the northwest portion of the fracture system, while Masalok Fracture Cave is located in the southeast portion. Numerous small pocket caves are located in the northeastern scarp wall along the entire length of the feature, however fewer are present in the regions where a southwestern wall is present. Throughout the feature, numerous speleothems are present on the cliff walls and within the small pocket caves, indicating that at some point in the past this feature was roofed. In the middle portions of the feature, where two cliff walls are exposed at the surface, the feature measures over 5 meters wide with a northeastern wall that is approximately 10 meters tall and a southwestern wall that is approximately 3 meters tall. Along the fracture, several less dissolutionally enhanced fractures are intersected at high angles to the primary fracture. In addition, several small collapse areas in the breakdown floor are present, indicating that greater void space is present at depth. This extensive, dissolutionally enhanced fracture system demonstrates the importance of fractures within carbonate islands as routes for the transfer of water into the subsurface.

Almost Cave (Upper Terrace, Aguijan – Figure 41)

Almost cave is a small, breached, flank margin cave located in the northwest region of the Upper Terrace in the Mariana Limestone (QTmu). The cave consists of two levels offset approximately 1 meter with a total width of 3 meters and depth of 1.5 meters. The cave is located 2 meters high on a small scarp with two entrances separated by a bedrock column. The cave has no speleothems and the floor is covered with alluvium.

Andyland Cave (Median Valley, Tinian – Figure 42)

Andyland Cave extends 20 meters inland from the northwest corner of Unai Dangkolo and is developed in the Mariana Limestone (QTmca). It is a flank margin cave consisting of one primary chamber with a maximum height of 3.5 meters and a width of 8 meters. The floor is composed of carbonate beach sand, which may be infilling additional cave passage in the western portions. Andyland Cave is positioned in-line with the northern scarp of Unai Dangkolo and Liyang Dangkolo, with a 10-meter gap separating Andyland Cave from Liyang Dangkolo. Based on carbonate sand observed in eastern portion of Liyang Dangkolo, it is likely that the two caves physically connect but are currently separated by sand accumulation.

Table 1: Cave and karst features surveyed on Tinian, CNMI: UTM location, physiography, cave type and geology.

Cave Name	Easting	Northing	Elevation	Location	Type	Lithology - Formation	Lithology - Facies
"600 Meter" Fracture System	356720	1659760	45	Southeastern Ridge	Fracture	Mariana Limestone	Detrital Undifferentiated Facies
Andyland Cave	354671	1662767	3	Median Valley	Flank Margin	Mariana Limestone	Constructional Algal Facies
Barcinas East Cave	350140	1657850	1	Median Valley	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Barcinas West Cave	349910	1657950	1	Median Valley	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Barely Cave	348420	1659160	50	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Bee Hooch Cave	355950	1657090	100	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Body Repel Cave	354190	1661480	125	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Broken Stal Cave	356190	1657460	100	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Cannon Cave	349525	1657825	40	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Carolina's Fracture Cave	352737	1661812	70	Southeastern Ridge	Fracture	Mariana Limestone	Detrital Undifferentiated Facies
Cave Without a Cave	353737	1661037	115	Southeastern Ridge	Flank Margin	Tagpochau Limestone	Detrital Facies
Cave Without a Roof	353087	1661187	120	Southeastern Ridge	Flank Margin	Tagpochau Limestone	Detrital Facies
Cavelet Cave	348340	1658020	3	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Central Mendiola Cave Complex	348140	1660090	1	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Cetacean Cave	355820	160780	1	Southeastern Ridge	Discharge	Mariana Limestone	Detrital Undifferentiated Facies
Chigel Fracture	355050	1665187	30	Central Plateau	Fracture	Mariana Limestone	Detrital Undifferentiated Facies
Cobble Cave	347090	1660260	1	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Coconut Trap Cave	356070	1657260	100	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Command Post Cave Complex	352540	1663370	130	North-Central Highland	Flank Margin	Mariana Limestone	Constructional Algal Facies
Cowrie Cave	347920	1660280	1	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
CUC Cave	351080	1656260	25	Median Valley	Banana Hole	Mariana Limestone	Constructional Algal Facies
Danko's Misery	355821	1654081	70	Southeastern Ridge	Fracture	Mariana Limestone	Constructional Algal Facies
Death Fracture Complex	348450	1657800	10	Central Plateau	Fracture	Mariana Limestone	Detrital Undifferentiated Facies
Dos Cenotes Cave	347870	1660290	1	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Dos Sakis Cave Complex	348020	1658160	50	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Dripping Tree Fracture Cave	354671	1662767	18	Median Valley	Fracture	Mariana Limestone	Constructional Algal Facies
Dump Coke Cave	349260	1663990	5	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Dynasty Cave	352610	1654230	1	Median Valley	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
East Suicide Cliff Cave (Suicide Cliff Cave #1)	354625	1651962	120	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Edwin's Ranch Cave	348387	1661600	60	Central Plateau	Flank Margin	Mariana Limestone	Constructional Coralliferous Facies
Elevator Cave	354070	1651350	130	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
False Floor Cave	356160	1657400	100	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Five Bee Cave Complex	354970	1654780	85	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Coralliferous Facies
Flamingo Tail Caves	348590	1658250	50	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Fleming Point Cave	347880	1661230	1	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Full Bottle Cave	356580	1659880	60	Southeastern Ridge	Fracture	Mariana Limestone	Detrital Undifferentiated Facies
Gecko Cave	355790	1660826	1	Median Valley	Discharge	Mariana Limestone	Detrital Undifferentiated Facies
Half-Dozen Cave	349562	1657960	45	Central Plateau	Flank Margin	Mariana Limestone	Detrital Facies
Headless Tourist Pit	353870	1650033	20	Southeastern Ridge	Pit	Mariana Limestone	Detrital Undifferentiated Facies
Hermit Crab Cave	356130	1657320	100	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Hidden Beach Cave	354590	1663410	1	Median Valley	Flank Margin	Mariana Limestone	Constructional Algal Facies
John's Small Cave	354260	1662350	20	Median Valley	Flank Margin	Mariana Limestone	Constructional Algal Facies
Lasu Recharge Cave	352225	1662012	100	North-Central Highland	Recharge	Tagpochau Limestone	Detrital Facies

Table 1 (continued): Cave and karst features surveyed on Tinian, CNMI: UTM location, physiography, cave type and geology.

Cave Name	Easting	Northing	Elevation	Location	Type	Lithology - Formation	Lithology - Facies
Leprosy Caves	350587	1656437	1	Median Valley	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Leprosy Discharge Feature	350062	1657025	1	Median Valley	Discharge	Mariana Limestone	Detrital Undifferentiated Facies
Liyang Barangka	356350	1656230	10	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Liyang Dangkolo	354320	1662360	20	Median Valley	Flank Margin	Mariana Limestone	Constructional Algal Facies
Liyang Diapblo	348230	1658080	1	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Liyang Gritot	351990	1665450	75	North-Central Highland	Flank Margin	Tagpochau Limestone	Detrital Facies
Liyang Mohlang	355187	1654550	150	Southeastern Ridge	Flank Margin	Tagpochau Limestone	Detrital Facies
Liyang Popporput	355925	1653368	150	Southeastern Ridge	Fracture	Mariana Limestone	Constructional Algal Facies
Liyang Sampapa	348270	1662790	5	Central Plateau	Discharge	Mariana Limestone	Constructional Algal Facies
Liyang Umumu	348300	1659110	30	Central Plateau	Banana Hole	Mariana Limestone	Detrital Undifferentiated Facies
Lower Sucide Cliff Cave Complex	355070	1651820	2	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Masalok Fracture Cave Complex	354590	1661880	15	Southeastern Ridge	Fracture	Mariana Limestone	Detrital Undifferentiated Facies
Mendiola Arch Cave Complex	348260	1659720	1	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Metal Door Cave	351710	1665310	80	North-Central Highland	Flank Margin	Tagpochau Limestone	Detrital Facies
Metal Spike Cave Complex	354426	1662341	20	Median Valley	Flank Margin	Mariana Limestone	Constructional Algal Facies
Metal Stretcher Cave	353775	1651075	115	Southeastern Ridge	Flank Margin	Tagpochau Limestone	Detrital Facies
Modified Cave	354212	1651440	100	Southeastern Ridge	Flank Margin	Tagpochau Limestone	Detrital Facies
Monica Wants to be Like Kevin Cave	348710	1658190	50	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
North Unai Dangkolo	354671	1662767	1	Median Valley	Flank Margin	Mariana Limestone	Constructional Algal Facies
Northern Playground Cave	355920	1657120	100	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Nuestra Senora de Santa Lourdes Cave Complex	351789	1656226	40	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Orange Cave	348350	1658050	10	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Pebble Cave	348030	1660240	1	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Pina Cave Complex	355990	1657170	100	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Playground Cave	355870	1657070	100	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Plunder Cave	352712	1651875	30	Median Valley	Fracture	Mariana Limestone	Detrital Undifferentiated Facies
Radio Inactive Cave	354200	1651490	130	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Red Snapper Cave	348150	1662080	10	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Rock Hammer Cave	348140	1660000	1	Central Plateau	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Rogue Cave	353090	1668610	1	Northern Lowland	Discharge	Mariana Limestone	Detrital Undifferentiated Facies
Rooticicle Cave	352913	1663561	100	North-Central Highland	Banana Hole	Mariana Limestone	Constructional Algal Facies
Skip Jack Cave	352610	1651560	2	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Skull Cave Complex	356020	1657170	100	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Skylight Cave	354190	1651420	130	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Solitary Cave	355890	1659350	80	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
South Mendiola Cave	348080	1659570	1	Central Plateau	Flank Margin	Mariana Limestone	Constructional Coralliferous Facies
South Unai Dangkolo	354600	1662100	2	Median Valley	Flank Margin	Mariana Limestone	Constructional Algal Facies
Swimming Hole Cave Complex	350960	1656670	10	Median Valley	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies
Twin Ascent Caves	354237	1651575	120	Southeastern Ridge	Flank Margin	Tagpochau Limestone	Detrital Facies
Unai Chiget	355337	1665312	2	Northern Lowland	Fracture	Mariana Limestone	Constructional Algal Facies
Unai Lamlam	353060	1668500	1	Northern Lowland	Flank Margin	Mariana Limestone	Constructional Coralliferous Facies
Unai Masalok	355212	1660674	5	Median Valley	Flank Margin	Mariana Limestone	Constructional Algal Facies
Water Cave	352687	1651850	25	Median Valley	Fracture	Mariana Limestone	Detrital Undifferentiated Facies
West Lasu Depression Cave	351270	1665220	40	Central Plateau	Recharge	Mariana Limestone	Detrital Undifferentiated Facies
West Suicide Cliff Caves	353187	1650600	115	Southeastern Ridge	Flank Margin	Mariana Limestone	Detrital Undifferentiated Facies

Table 2: Cave and karst features surveyed on Aguijan, CNMI: UTM location, physiography, and cave type.

Cave Name	Easting	Northing	Elevation	Location	Type
Almost Cave	343450	1642170	150	Upper Terrace	Flank Margin
Anvil Cave	343670	1642560	150	Upper Terrace	Fracture
Biting Mosquitoes Cave	343380	1642140	150	Upper Terrace	Flank Margin
Booney Bee Sink	343440	1642140	150	Upper Terrace	Banana Hole
Cabrito Cave	346675	1642675	70	Middle Terrace	Flank Margin
Diamond Cave	344337	1641687	50	Lower Terrace	Flank Margin
Dove Cave	343280	1642560	150	Upper Terrace	Banana Hole
Goat Cave	344538	1641684	55	Lower Terrace	Flank Margin
Goat Island Fracture Cave	343840	1642820	50	Lower Terrace	Fracture
Hollow Column Cave	354260	1662350	50	Lower Terrace	Flank Margin
Insect Bat Cave	343810	1641550	60	Middle Terrace	Fracture
Isotope Cave	343320	1642050	150	Upper Terrace	Flank Margin
Liyang Atkiya	345246	1641755	50	Lower Terrace	Unknown
Liyang Lomuk	345210	1643260	100	Middle Terrace	Flank Margin
Lizard Cave	345140	1643240	100	Middle Terrace	Flank Margin
Natural Arch Cave	344140	1641580	60	Middle Terrace	Flank Margin
Orphan Kids Cave Complex	343198	1641434	50	Lower Terrace	Fracture
Pepper Cave	343230	1642070	150	Upper Terrace	Flank Margin
Scorpion Cave	346680	1642680	70	Middle Terrace	Flank Margin
Screaming Bat Cave	343340	1642110	140	Upper Terrace	Flank Margin
Spider Cave	345070	1643200	100	Middle Terrace	Flank Margin
Swarming Termites Cave	346560	1642740	70	Middle Terrace	Flank Margin
Swiftlet Cave	343180	1642620	15	Lower Terrace	Flank Margin
Toppled Column Cave	343940	1641560	60	Middle Terrace	Fracture
Tridactid Cave Complex	346670	1642670	70	Middle Terrace	Flank Margin
Waypoint Cave	346510	1642660	70	Middle Terrace	Flank Margin

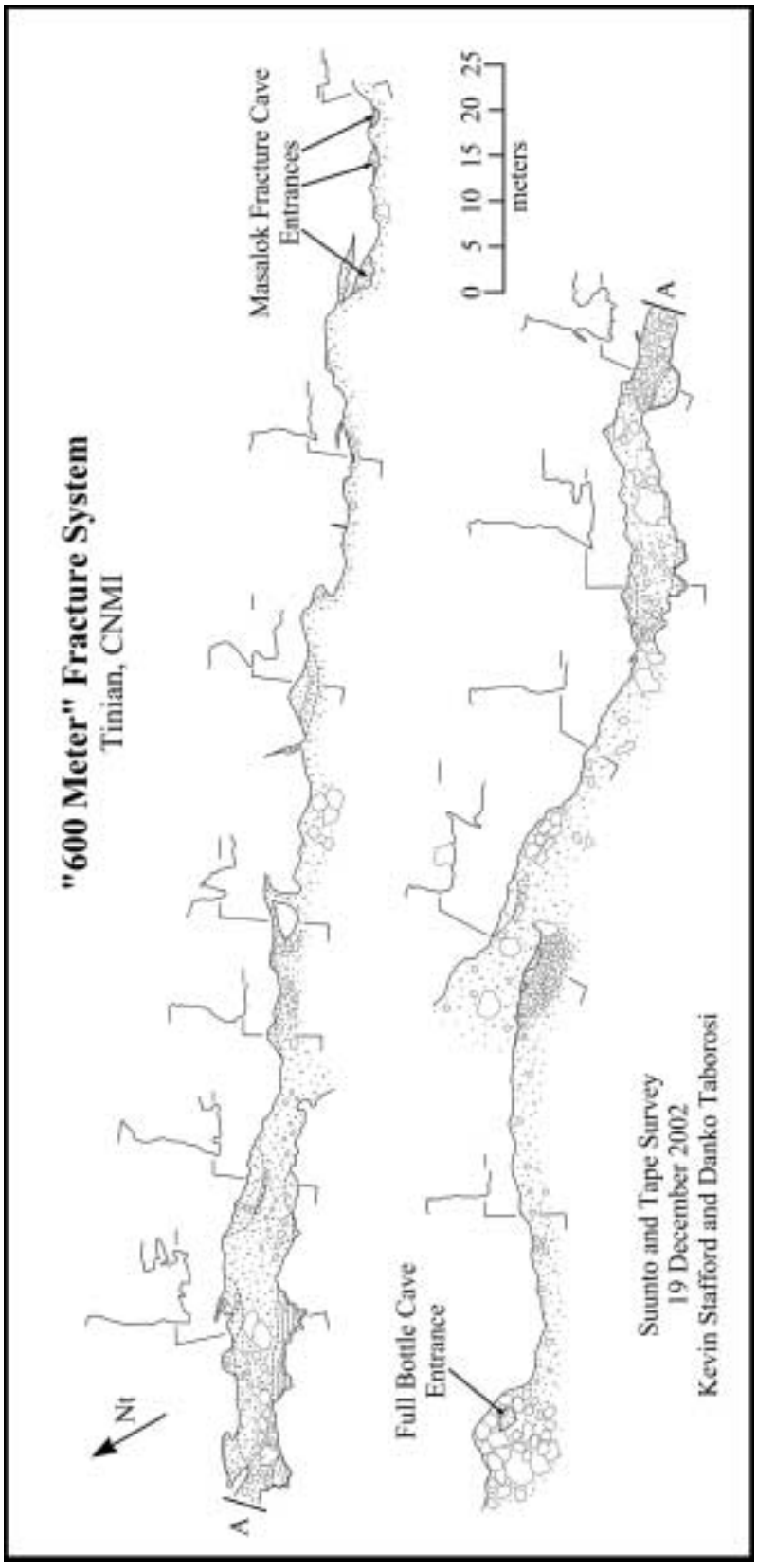

Figure 40: Map of "600 Meter" Fracture System.

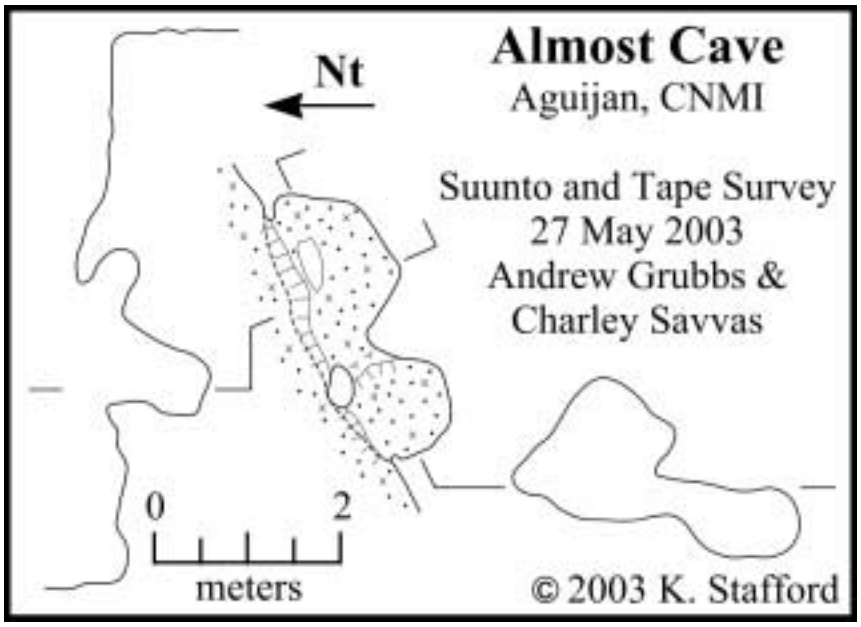

Figure 41: Map of Almost Cave.

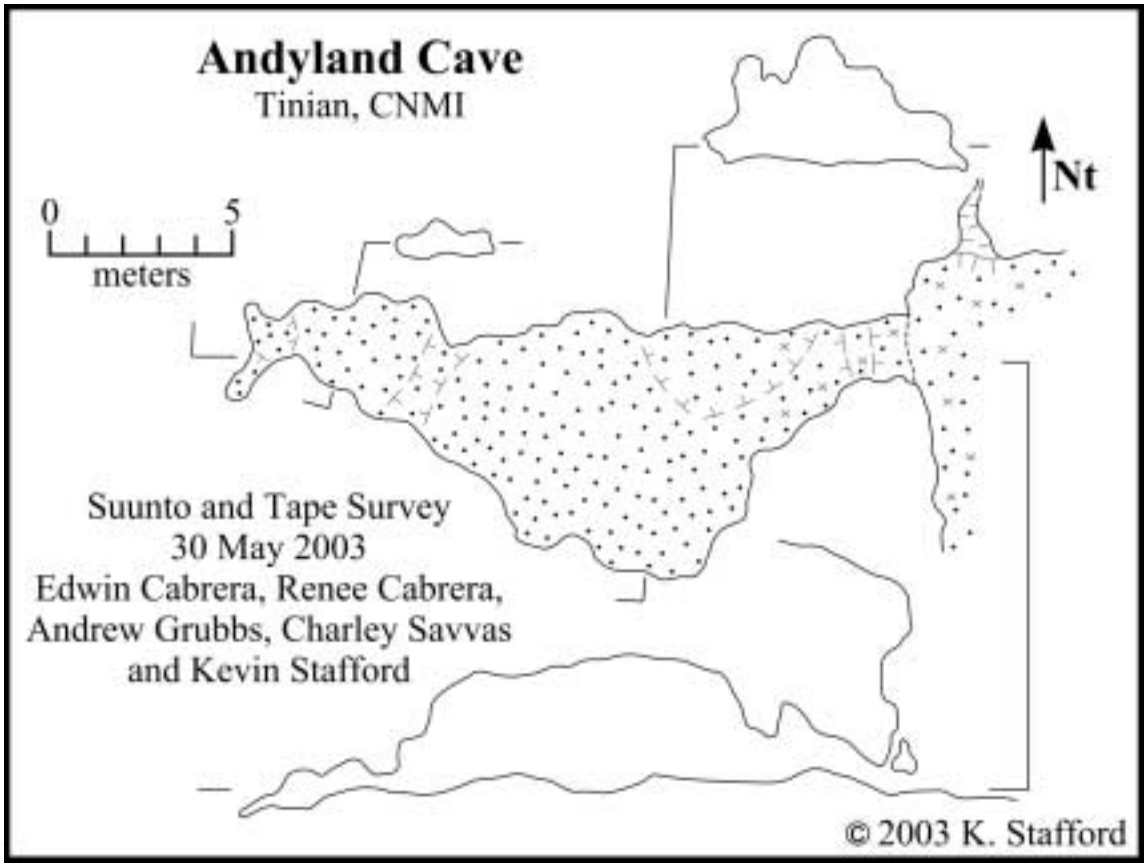

Figure 42: Map of Andyland Cave.

Anvil Cave (Upper Terrace, Aguijan – Figure 43)

Anvil Cave is a fracture cave developed from scarp failure in the northwest region of the Upper Terrace. It is developed in the Mariana Limestone (QTmu) along a fracture strike of 45°. The cave consists of two primary levels. The upper level is partially roofed, 10 meters long and 3 meters wide with a bedrock shelf extending 2 meters to the northwest. The lower level averages 3 meters in width and drops steeply to the northeast over a breakdown floor, with a small breakdown chamber located to the west. The cave continues as a 5 meter wide, 9 meter deep, alluvium floored canyon to the northeast, connecting the Upper and Middle Terraces. The cave contains minor speleothem deposits and is composed primarily of breakdown with enhanced dissolution along the fracture trend and shows evidence of military occupation and modification.

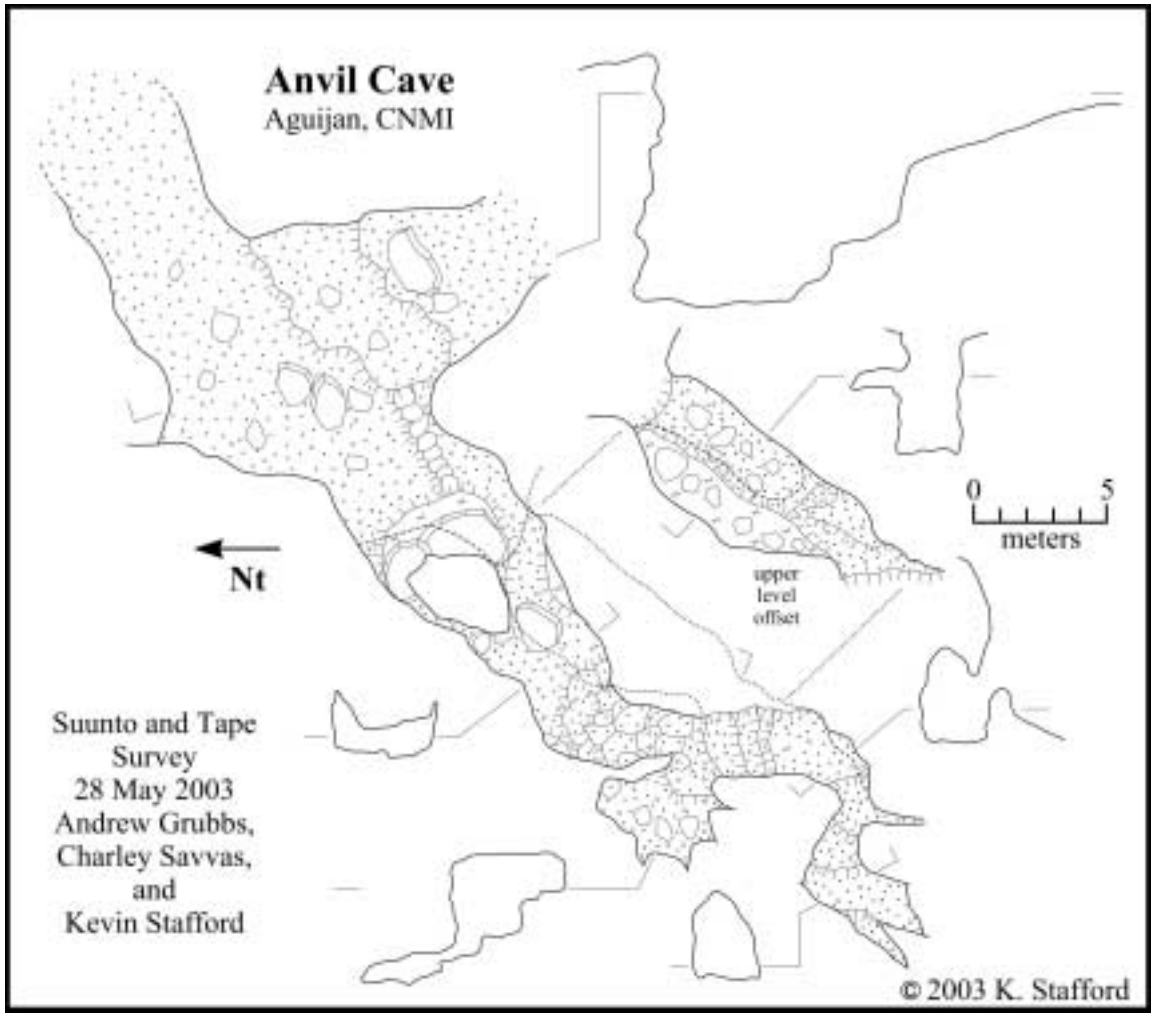

Figure 43: Map of Anvil Cave.

Barcinas East Cave (Median Valley, Tinian – Figure 44)

Barcinas East Cave is a flank margin cave located approximately 200 meters east of Barcinas West Cave on the north side of Barcinas Cove (Turtle Cove) in the Mariana Limestone (QTmu). It is positioned approximately 1 meter above mean sea level with a width of 34 meters, depth of 18 meters and maximum ceiling height of 4 meters. The main cave is separated by 3 bedrock pillars and is influenced by two joints trending north/northeast. The interior of the main

cave is devoid of speleothems and appears to have been severely impacted by intense storm events, producing a flat bedrock floor that is near level with high tide levels. A few meters west of the main cave, a smaller flank margin remnant exists that is partially protected by the rock comprising the main cave, which extends slightly farther seaward.

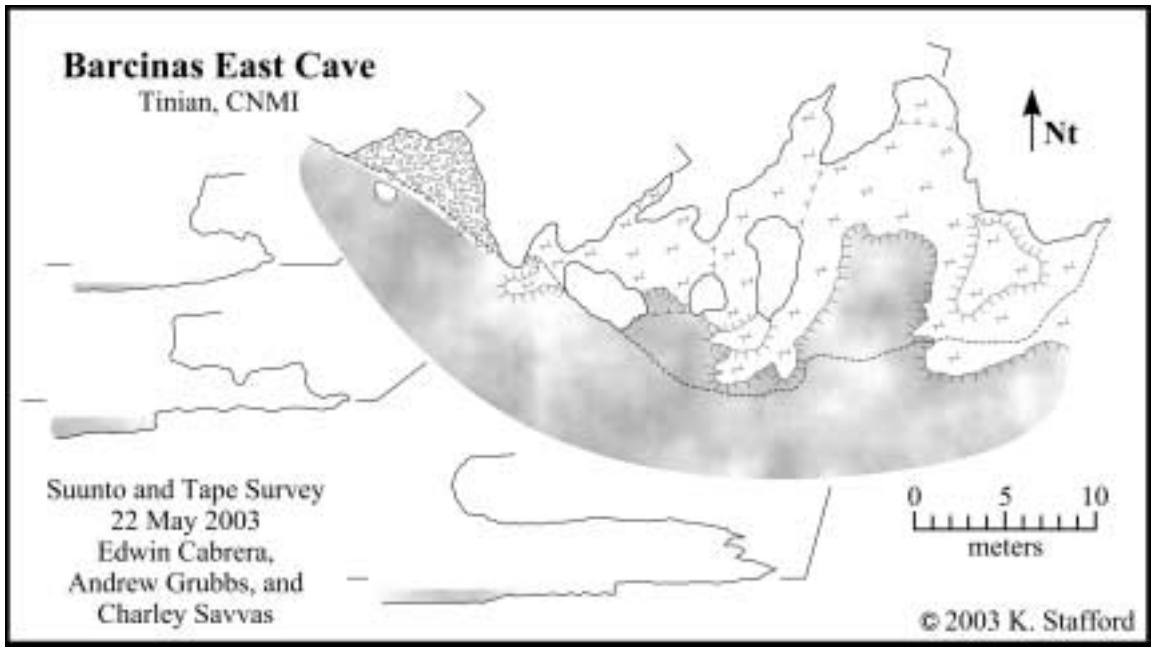

Figure 44: Map of Barcinas East Cave.

Barcinas West Cave (Median Valley, Tinian – Figure 45)

Barcinas West Cave is a flank margin cave located approximately 200 meters west of Barcinas East Cave on the north side of Barcinas Cove (Turtle Cove) in the Mariana Limestone (QTmu). It is a single chamber positioned approximately 1 meter above mean sea level with a width of 22 meters, depth of 15 meters, and maximum ceiling height of 5 meters. A single small column divides the entrance in half, although a large breakdown block in the western portion of entrance gives the appearance of dividing the cave into three entrances. The cave is partially protected from the direct impact of waves by a large resistant bedrock pillar is located approximately 6 meters south of the entrance. Extending 5 meters to the east of the cave is a small passage that is developed along a joint. The cave is devoid of speleothems and the floor is covered with large breakdown blocks and cobbles that have been well rounded by wave action.

Barely Cave (Central Plateau, Tinian – Figure 46)

Barely Cave is a remnant, flank margin cave that is located approximately 600 meters southeast of Puntan Diapblo at sea-level in the Mariana Limestone (QTmu). The cave is 38 meters wide and 18 meters deep and appears to have been severely impacted by intense storm events. The majority of the feature is unroofed, with a partial roof existing on the southeast side of the feature in the region were the cave floor is below sea level. The northern portion of the feature has a bedrock floor, while minor amounts of heavily eroded flowstone exist on the floor of the east-central portion of the cave. Although heavily impacted by coastal processes, the presence of flowstone confirms a spelean origin for the feature.

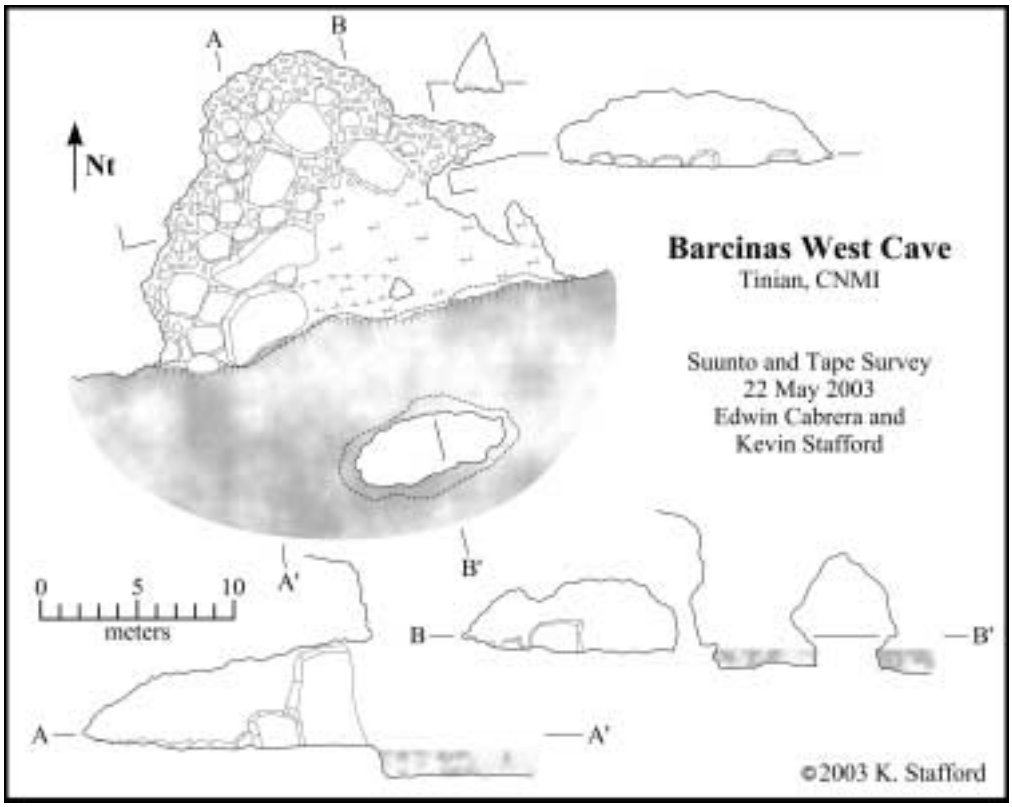

Figure 45: Map of Barcinas West Cave.

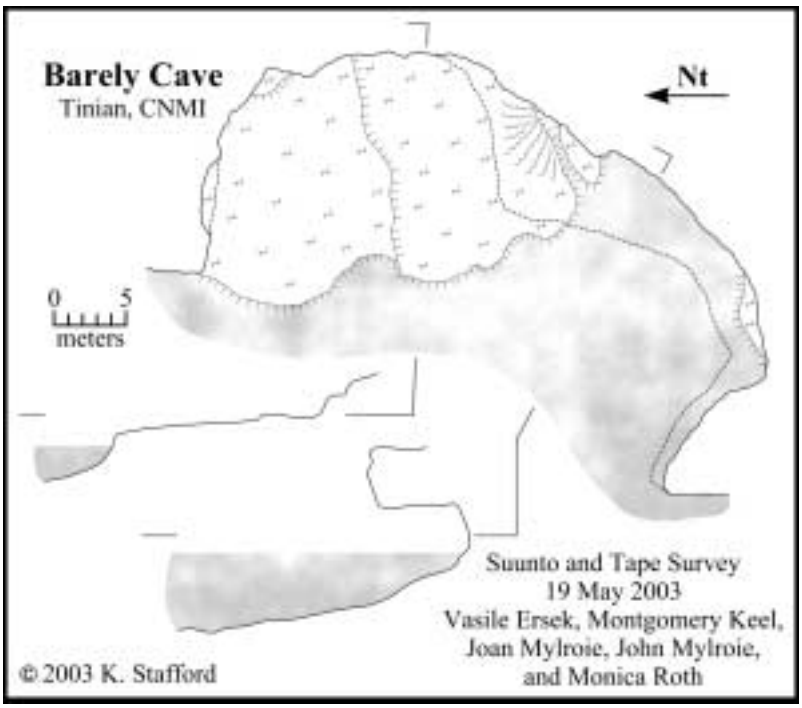

Figure 46: Map of Barely Cave.

Bee Hooch Cave (Southeastern Ridge, Tinian – Figure 47)

Bee Hooch Cave is located along the southeastern scarp of the Piña ridge in the Mariana Limestone (QTmu). It is a flank margin cave breached by cliff retreat with an entrance width of 12 meters, depth of 9 meters and ceiling height of 4.5 meters. The cave has been extensively modified by humans, including the addition of wooden floors that are highly deteriorated in the northwest and northeast portions of the cave. The cave contains minor amounts of flowstone along the walls and has a floor comprised primarily of soil and small breakdown blocks.

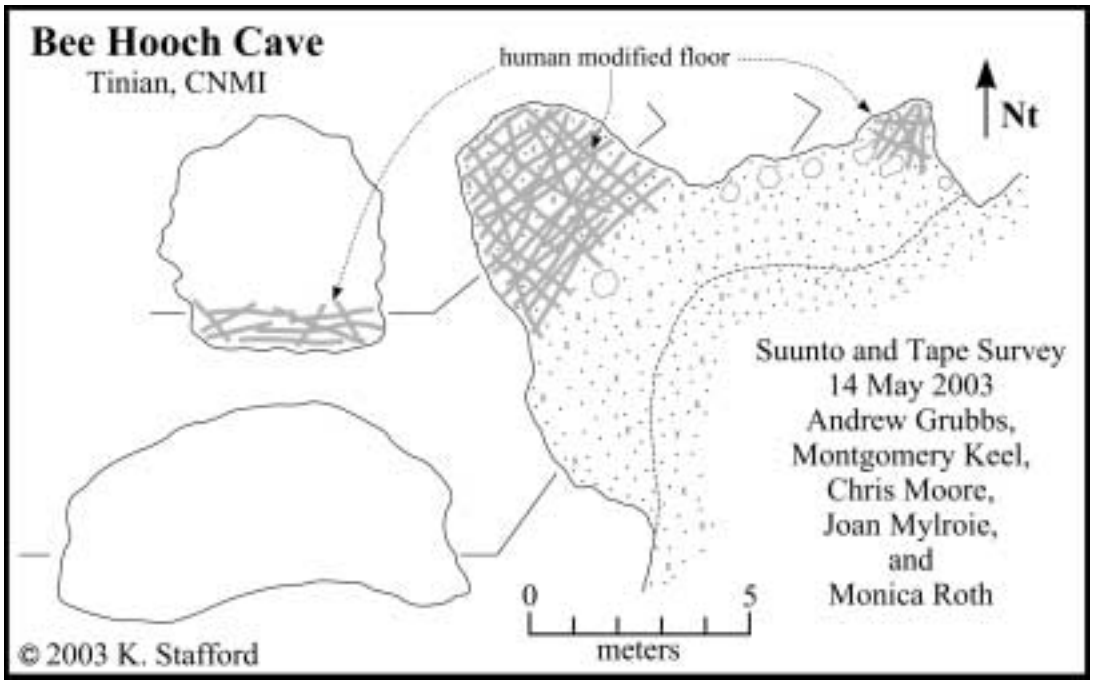

Figure 47: Map of Bee Hooch Cave.

Biting Mosquitoes Cave (Upper Terrace, Aguijan – Figure 48)

Biting Mosquitoes Cave is a small, breached flank margin cave located in the northwest region of the Upper Terrace in the Mariana Limestone (QTmu). It consists of a single chamber 8 meters wide and 10 meters deep with an average ceiling height of 1.5 meters. The floor is primarily composed of alluvium, but speleothem deposits are present in the northwest portion of the cave, forming a large flowstone mound. There is a collapsed, man-made wall in the entrance of the cave.

Body Repel Cave (Southeastern Ridge, Tinian – Figure 49)

Body Repel Cave is a breached, flank margin cave located in the central region of Suicide Cliffs approximately 5 meters below the top of the scarp. It is developed in the Mariana Limestone (QTmu), has a width of 24 meters exposed along the cliff, a depth of 7 meters and maximum ceiling height of 6 meters. This cave remnant represents the inland wall of a larger flank margin chamber that has almost been removed by scarp retreat. The ceiling covers approximately seventy percent of the floor area, which consists of several small terraces.

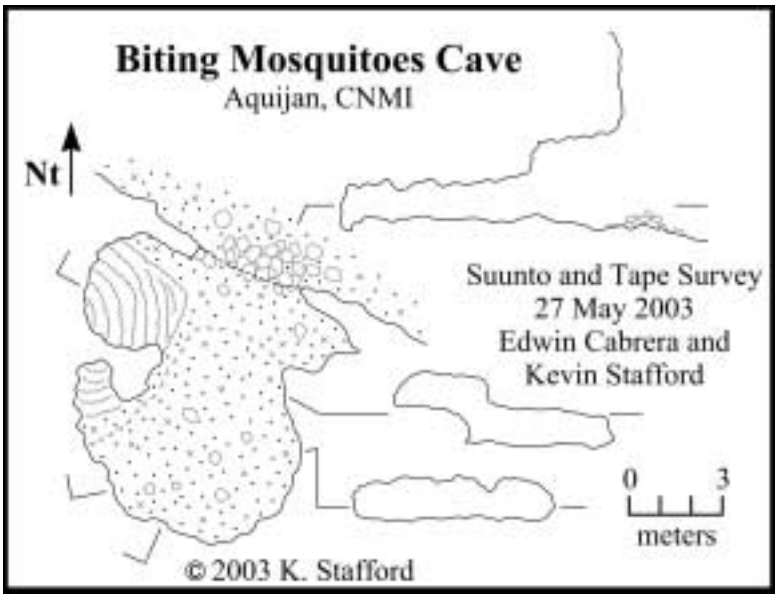

Figure 48: Map of Biting Mosquitoes Cave.

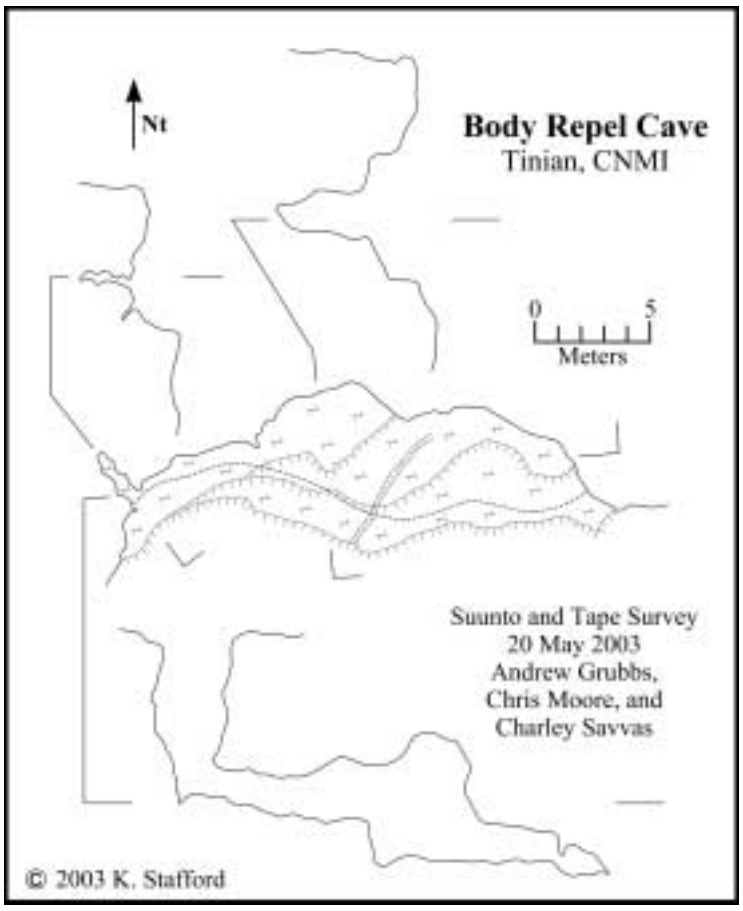

Figure 49: Map of Body Repel Cave.

Booney Bee Sink (Upper Terrace, Aguijan – Figure 50)

Booney Bee Sink is a small banana hole type cave located in the northwest region of the Upper Terrace in the Mariana Limestone (QTmu). It is 1 meter wide, 4 meters long and up to 1 meter tall, with a floor composed of alluvium and a small passage continuing from the southeast corner of the cave. This feature appears to take some local recharge when precipitation exceeds local infiltration rates, but the area affected appears to be limited to a few square meters.

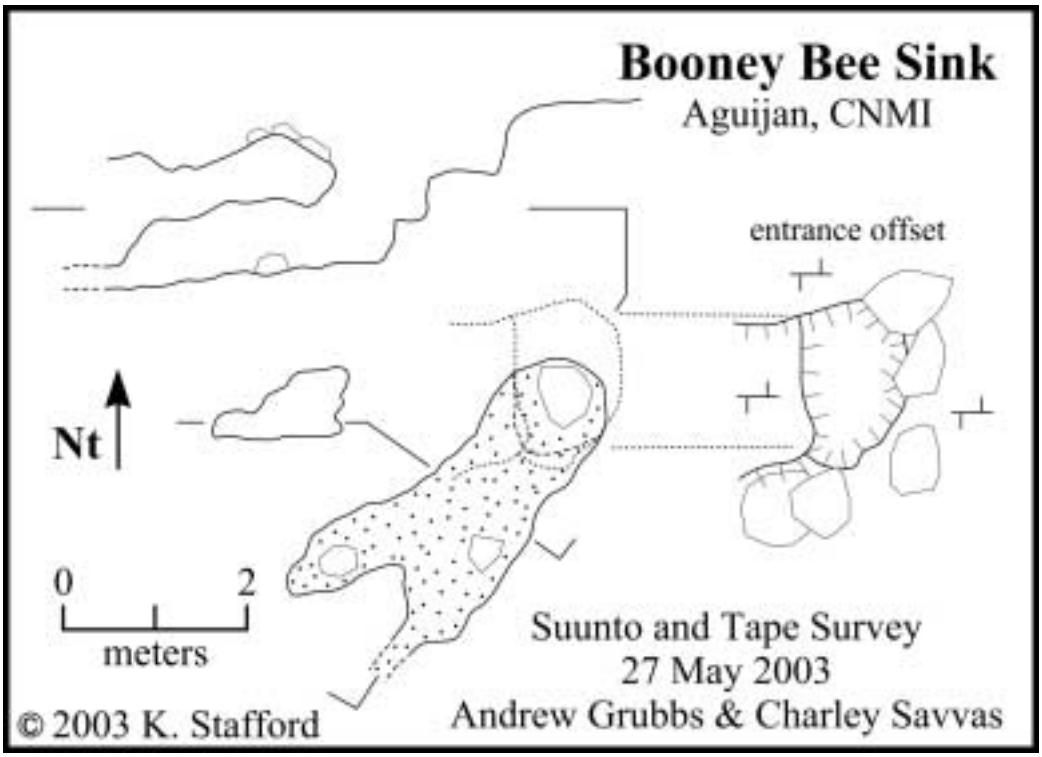

Figure 50: Map of Booney Bee Sink.

Broken Stal Cave (Southeastern Ridge, Tinian – Figure 51)

Broken Stal Cave is located along the southeastern scarp of Piña ridge in the Mariana Limestone (QTmu) and contains limited speleothem deposits except for a single 6-centimeter tall stalagmite in the south-central portion. The main cave remnant is 5 meters wide at the entrance and splits into two smaller passages that join 6 meters inland. The cave is 4 meters tall in the entrance area where the floor is composed of soil and detritus, but the floor is elevated at a 2-meter tall ledge, 1-meter inland from the cave entrance, where the floor becomes bedrock. A 1-meter wide, 2-meter deep bedrock column separates the two passages, while an additional 1 to 2 meters of bedrock separate the main cave from a smaller cave remnant to the south.

Cabrito Cave (Middle Terrace, Aguijan – Figure 52)

Cabrito Cave is a small, breached flank margin cave located in the eastern region of the Middle Terrace in the Mariana Limestone (QTmu). It is 5 meters wide, 2 meters deep and has a maximum height of 2.5 meters. The floor is composed of alluvium in the entrance area and bedrock in the inland portions. The cave contains slightly elevated floor regions in the northern and southern portions, forming a lowered, "trench-like" region in the central portion that is the same elevation as the region near the entrance.

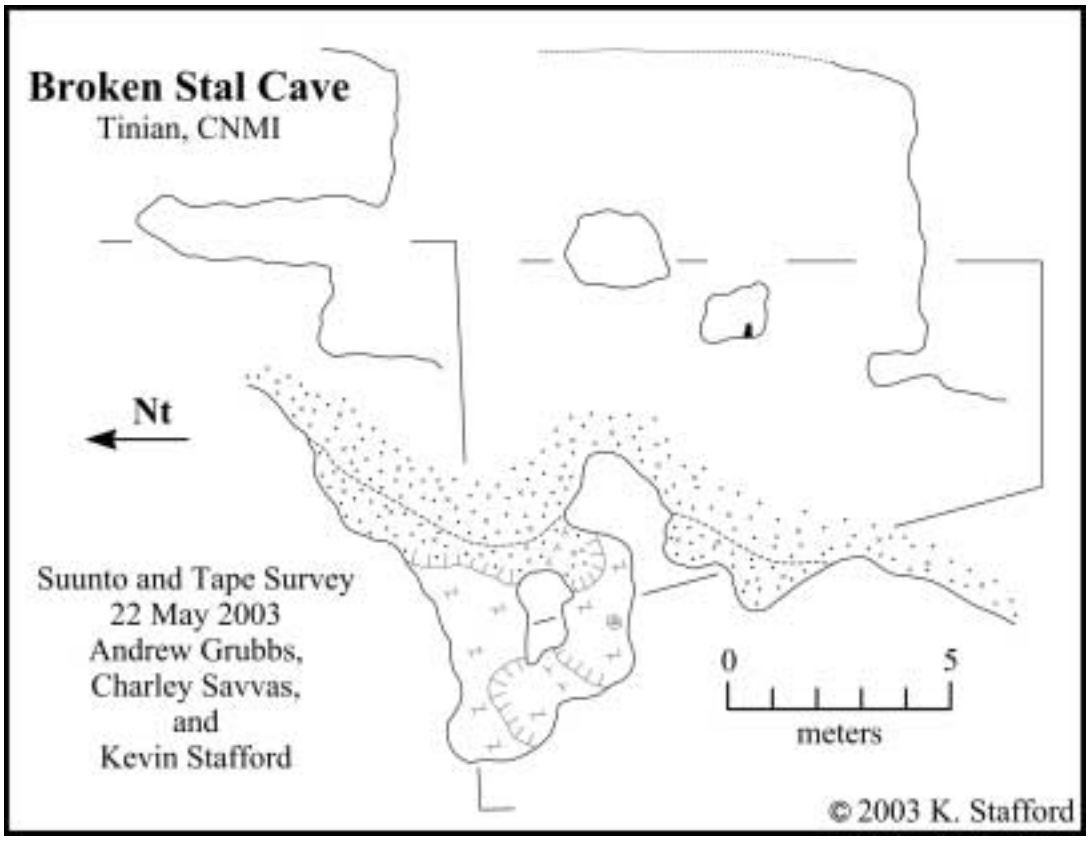

Figure 51: Map of Broken Stal Cave.

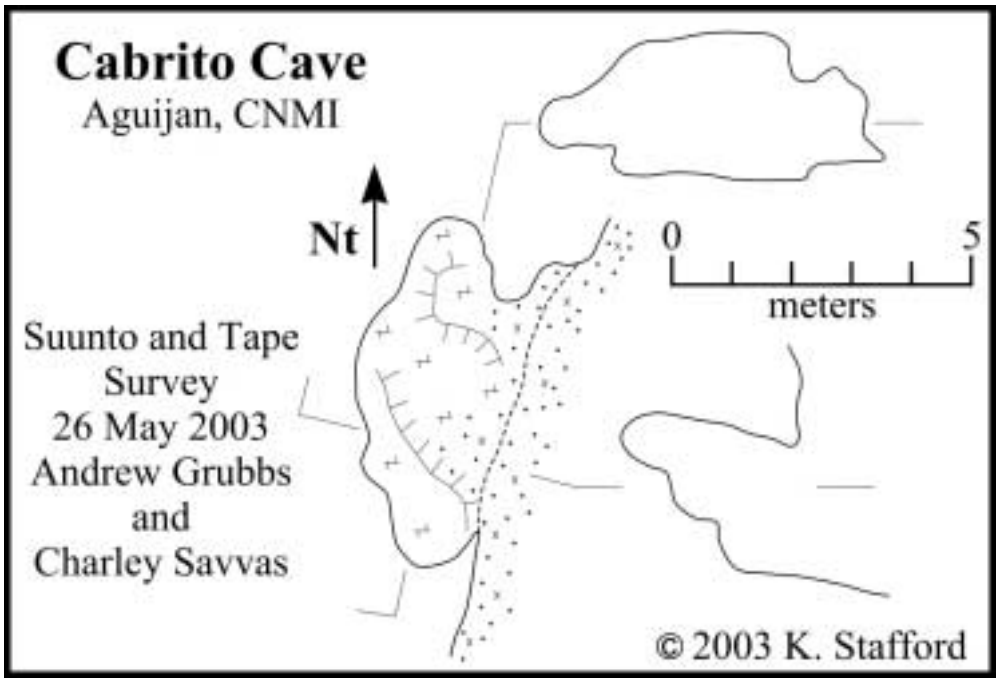

Figure 52: Map of Cabrito Cave.

Cannon Cave (Central Plateau, Tinian – Figure 53)

Cannon Cave is a modified flank margin cave formed in the Mariana Limestone (QTmu). It is located approximately 2 kilometers east of Puntan Diapblo, approximately 300 meters north of the coast. The cave was modified and used as a defensive position by the Japanese during World War II and still contains a 5-meter long, 16-centimeter Japanese gun. The natural chamber is 5 meters by 12 meters with a ceiling height of 5 meters. Extending to the East is a 5-meter long, 1.5-meter square dug, tunnel probably used to store ammunition. This feature appears to have had little modification to the ceiling and the walls of the main chamber, but the floor appears to have had significant modification for use as a defensive position.

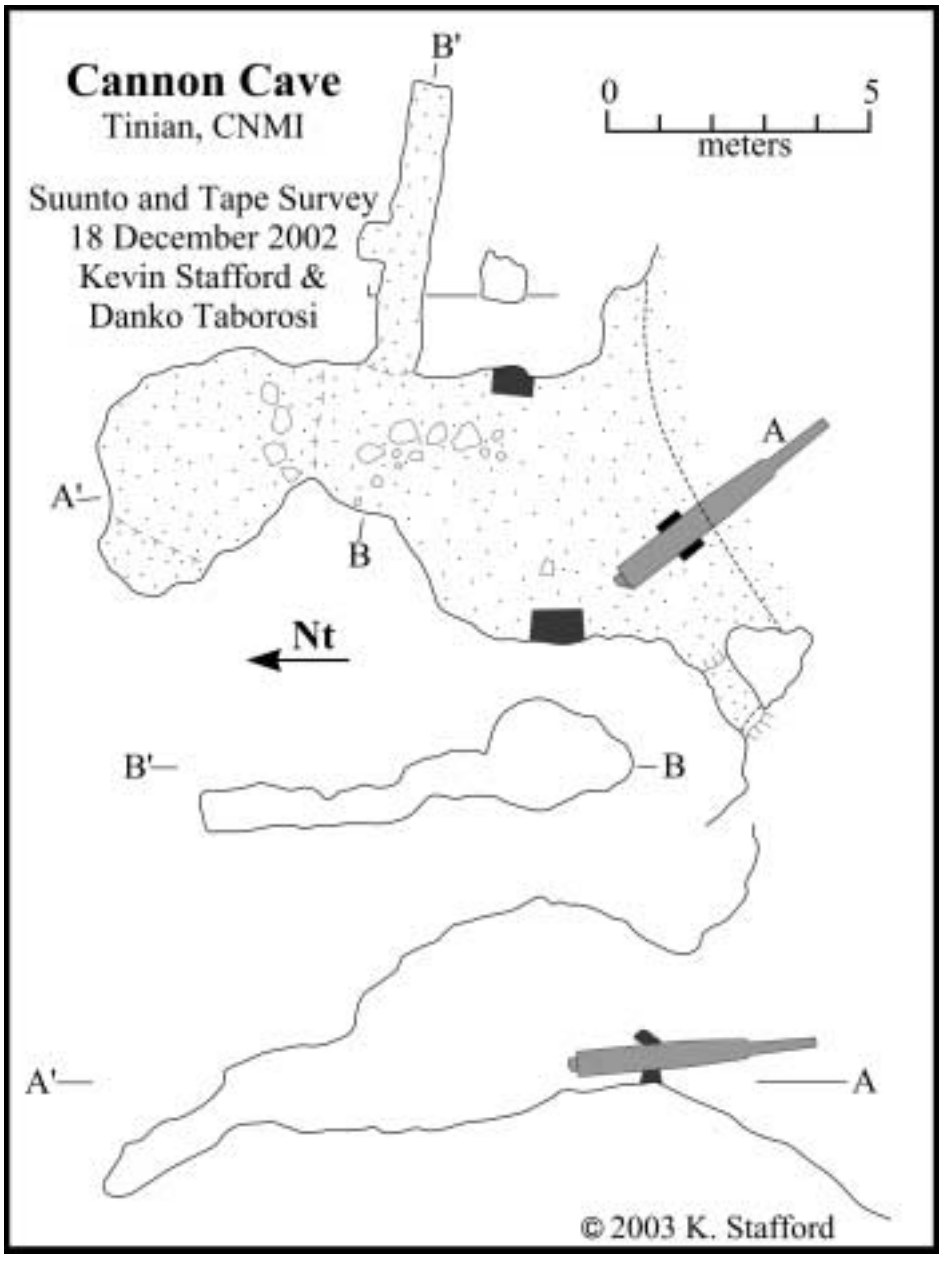

Figure 53: Map of Cannon Cave.

Carolinas Fracture Cave (Southeastern Ridge, Tinian – Figure 54)

Carolinas Fracture Cave is located in Carolinas Limestone Forest, approximately 500 meters east of the ocean and oriented roughly parallel to the cliff margin. This feature is developed in the Mariana Limestone (QTmu) as a result of the dissolutional widening of a fracture created by cliff margin retreat. The feature trends northeast (~50°) and extends for approximately 70 meters, with an average width of 2 meters and maximum depth of 16 meters. Approximately one half of the feature is roofed with large breakdown blocks, comprising the northeastern portion of the feature, which intersects the cliff line that is retreating. The cave shows extensive speleothems covering the walls in the roofed section with lesser amounts in the unroofed portions.

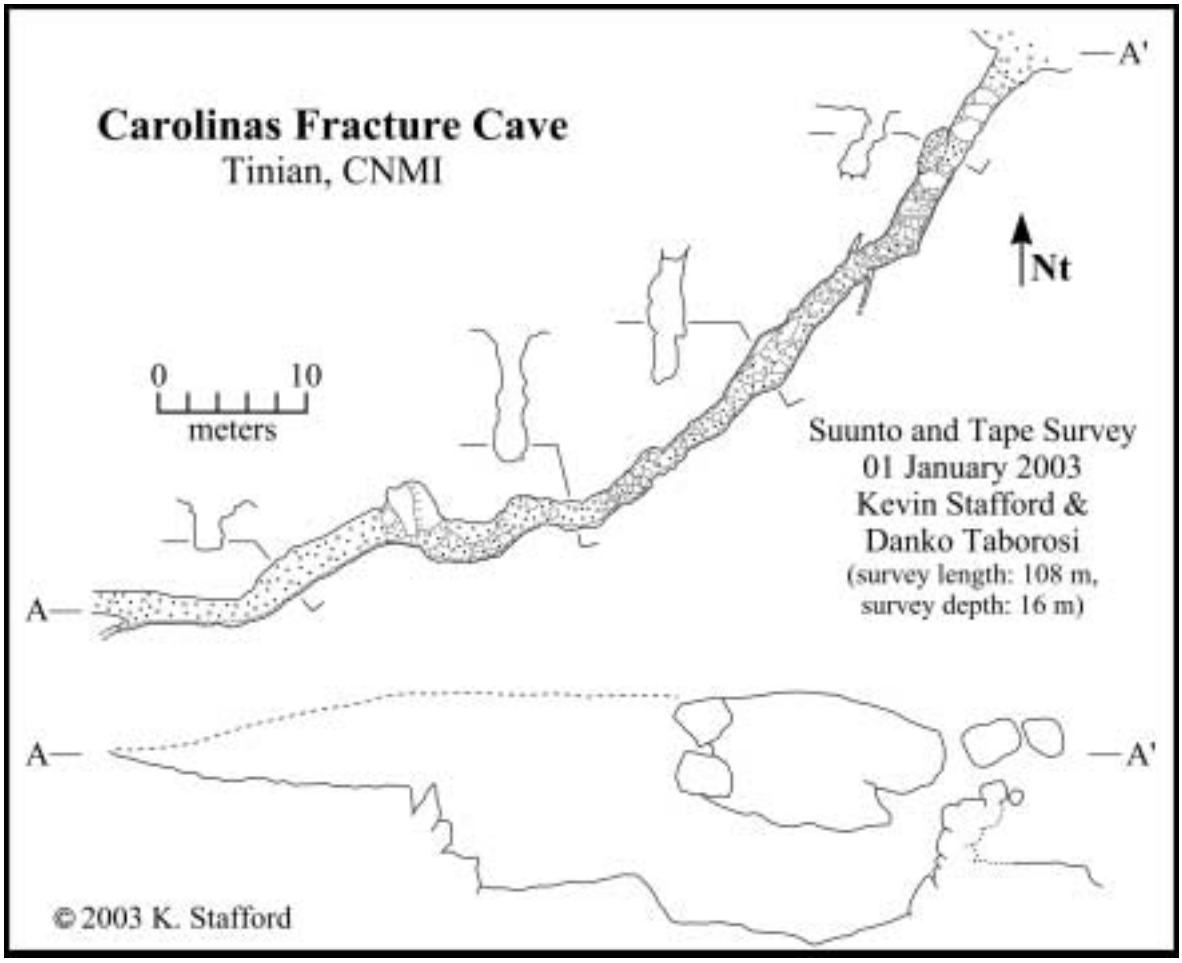

Figure 54: Map of Carolinas Fracture Cave.

Cave Without a Cave (Southeastern Ridge, Tinian – Figure 55)

Cave Without a Cave is an extreme end member of a remnant flank margin cave breached by cliff retreat. It is located in the central portion of Suicide Cliffs, approximately 20 meters above the base of the cliff and is developed in the Tagpochau Limestone (Tt). This feature is 20 meters wide, 5 meters deep, 5 meters tall and apparently represents the most inland wall of a flank margin cave. The cave has undergone extensive erosion, but some minor speleothems are present.

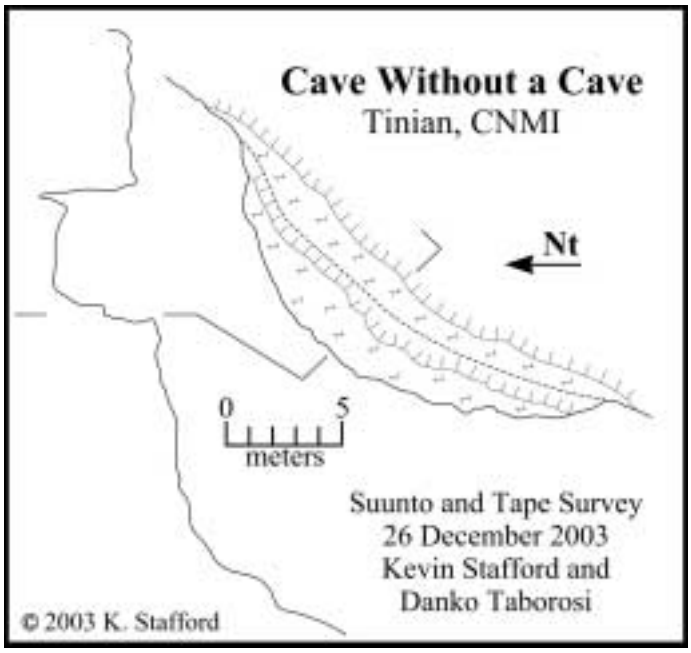

Figure 55: Map of Cave Without a Cave.

Cave Without a Roof (Southeastern Ridge, Tinian – Figure 56)

Cave without a Roof is an intersected flank margin cave located in the central portion of Suicide Cliffs, approximately 25 meters above the base of the cliff, developed in the Tagpochau Limestone (Tt). It is a single, remnant chamber that is 5 meters by 14 meters in size, with a ceiling height of 5 meters. The cave contains only minor speleothems possibly because it has undergone extensive collapse as part of cliff retreat. The roof is missing in most portions of the cave, representing an intermediate stage in the process of cliff retreat where the cave has not only been breached, but the cave roof has been removed by erosional processes.

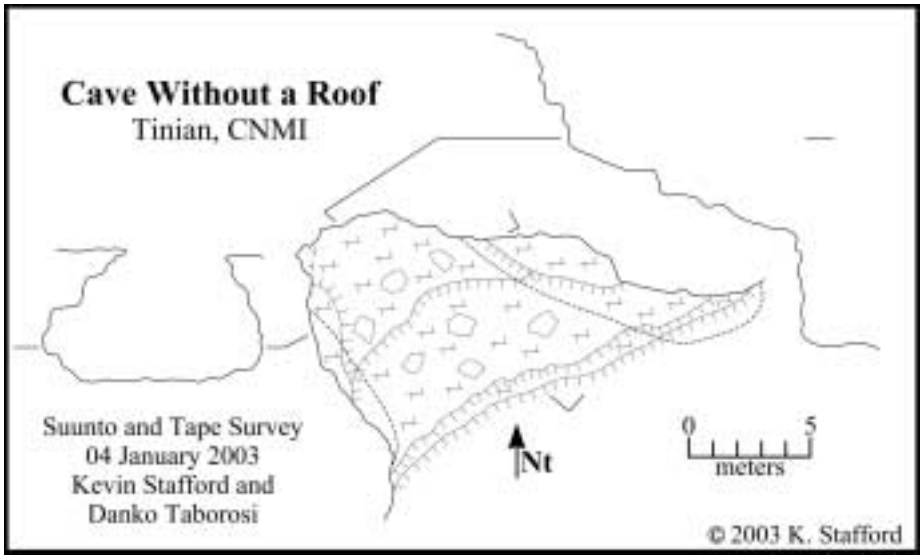

Figure 56: Map of Cave Without a Roof.

Cavelet Cave (Central Plateau, Tinian – Figure 57)

Cavelet Cave is a small, remnant, flank margin cave located approximately 500 meters southeast of Puntan Diapblo. The cave, developed in the Mariana Limestone (QTmu), has an entrance 4 meters wide, extends inland 5 meters, and has an average ceiling height of 1.5 meters. The cave is located 3 meters above sea level and approximately 100 meters inland. The floor is composed of bedrock with small breakdown blocks, while the cave is devoid of speleothems, possibly as a result of intense storm events.

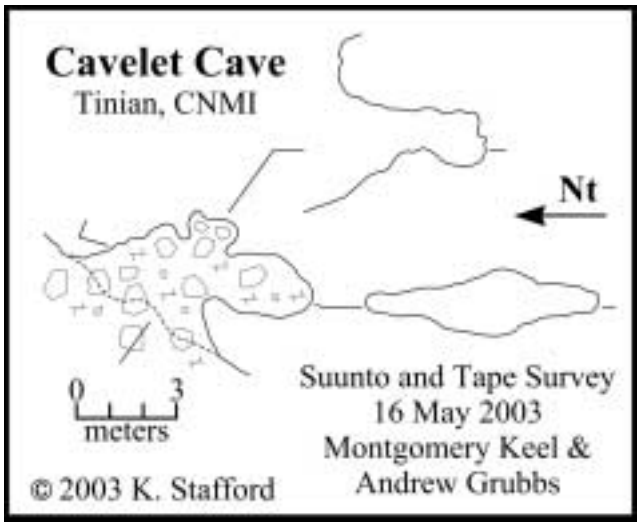

Figure 57: Map of Cavelet Cave.

Central Mendiola Cave Complex (Central Plateau, Tinian – Figure 58)

Central Mendiola Cave Complex is located in the central region of a large cove approximately 800 meters southeast of Puntan Atgidon, which is locally referred to as Mendiola Cove after the landowner. This cave complex is developed in the Mariana Limestone (QTmu) and covers 150 meters of coastline. The breached, flank margin caves extend inland up to 20 meters with and average ceiling height of 4 meters. They are located slightly above mean sea level and primarily contain bedrock floors with weathered breakdown blocks and cobbles. Smaller cave chambers exist at the north and south ends of the surveyed cave complex with the largest chamber located in the central region. The largest chamber has an entrance 50 meters wide and extends inland 15 meters as a single large chamber. There is a sea stack located at its southern margin that may represent a previous bedrock column. To the south of the largest cave, the deepest cave extends inland 20 meters with average width of 8 meters, while to the north of the largest cave a chamber divided by a 2 meter wide, 10 meter long bedrock column extends inland 15 meters. This series of breached, flank margin caves appear to have been connected as a single cave in the past based on the proximity of the individual cave remnants and their corresponding ceiling drip lines.

Cetacean Cave (Southeastern Ridge, Tinian – Figure 59)

Cetacean Cave is located 250 meters southeast of Unai Masalok in the Mariana Limestone (QTmu) near and parallel to a large fault scarp, which trends 85^{o}. The cave is developed along a joint that can be observed in the ceiling, while significant freshwater discharges from the fracture in the floor. The cave extends 25 meter inland with and average width of 3 meters and ceiling height between 2 and 3 meters. The entrance area is partially

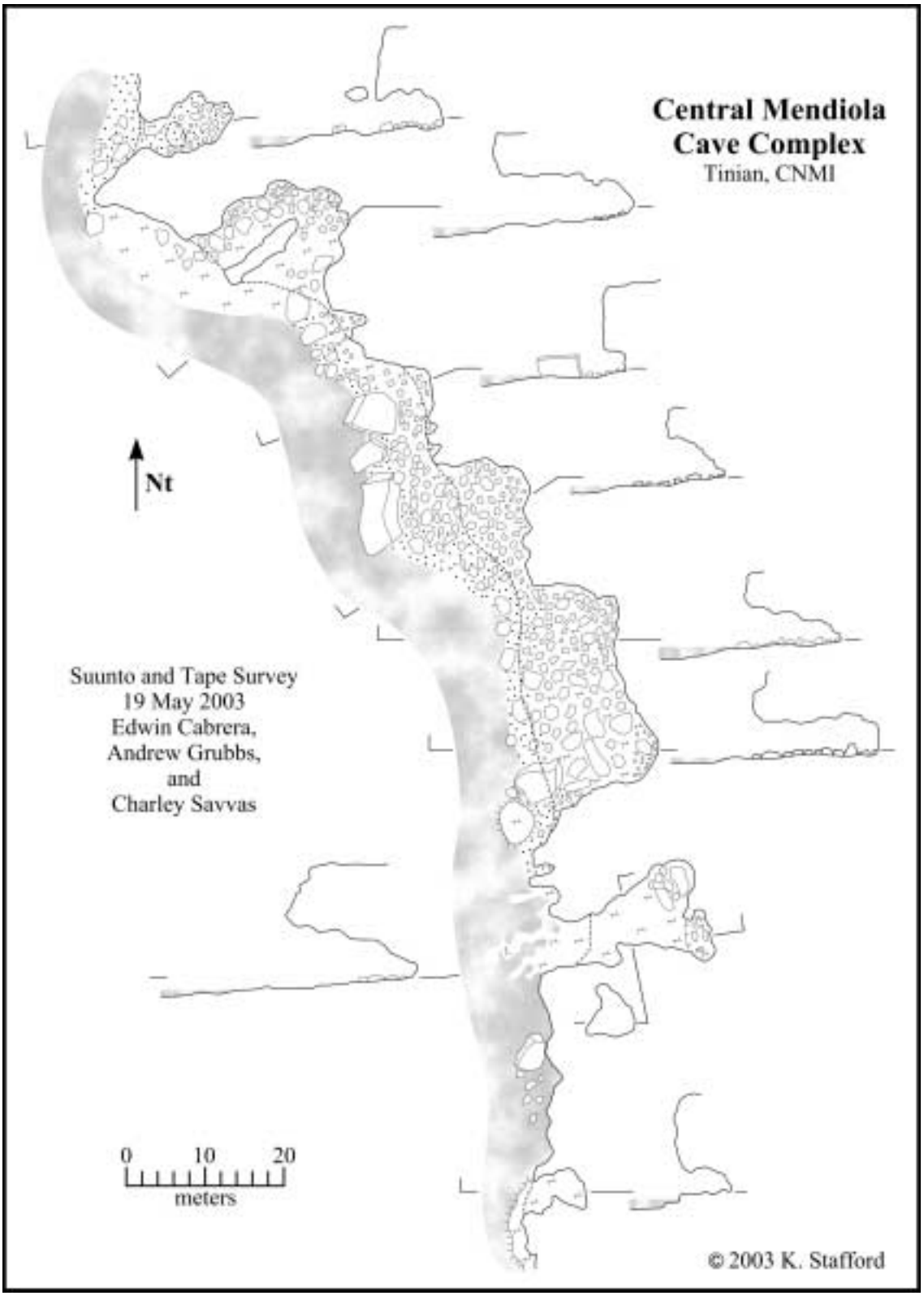

Figure 58: Map of Central Mendiola Cave Complex.

obstructed by two large breakdown blocks, while the presence of numerous fishing net floats wedged into the ceiling joint is evidence of intense wave impact. The majority of the cave has a bedrock floor submerged under 0.25 to 0.5 meters of water with some weathered breakdown blocks and cobbles protruding above water level. It appears that the cave formed by freshwater discharging along a fracture, resulting in the headward dissolution of limestone enhanced by the mixing of fresh and salt waters.

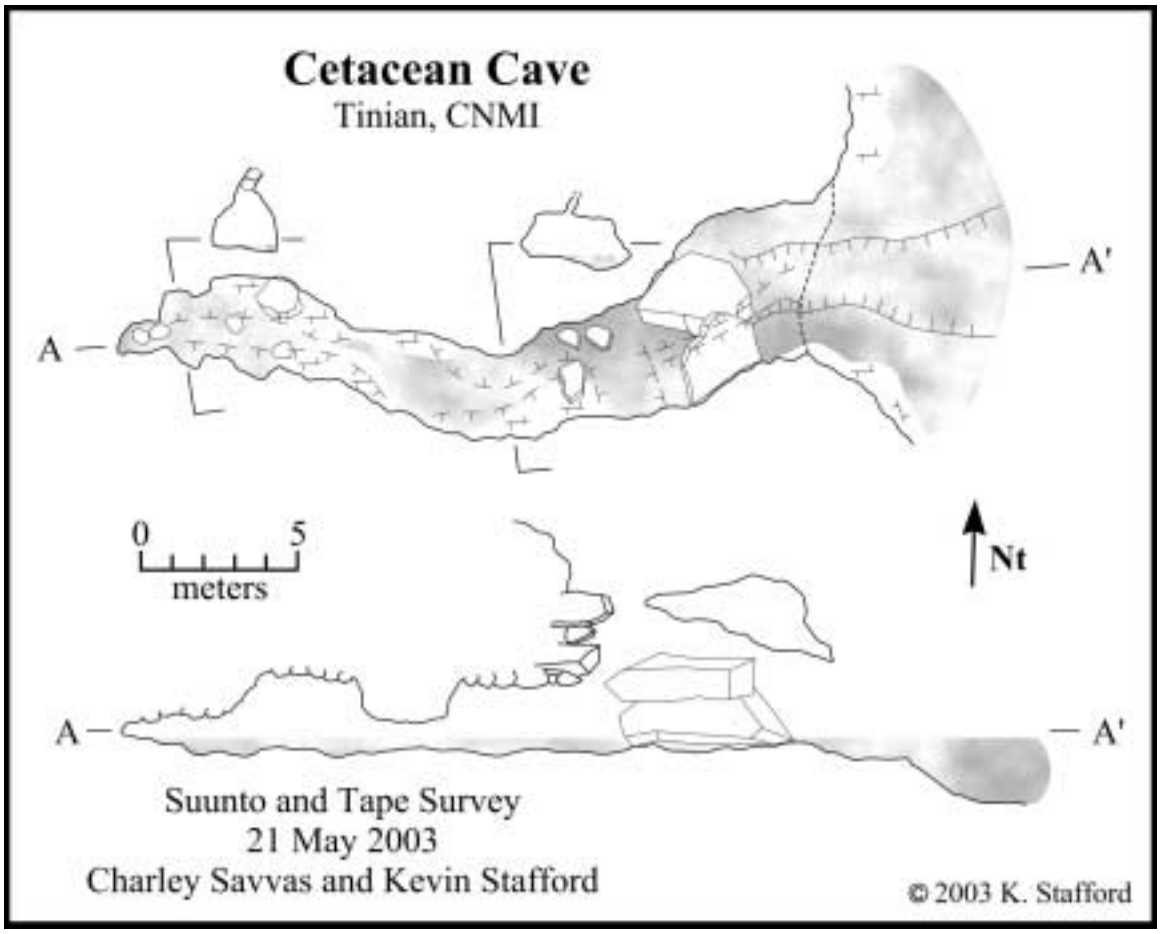

Figure 59: Map of Cetacean Cave.

Chiget Fracture (Central Plateau, Tinian – Figure 60)

Chiget Fracture is located on the southern wall of the Unai Chiget Fault scarp, approximately 500 meters inland. It is developed in the Mariana Limestone (QTmu) and is a dissolutionally widened fracture that is oriented northeast (~50 ^{o}) and intersected by a smaller fracture oriented east/southeast (~105 ^{o}) in the inland portion. The main fracture is approximately 20 meters long, 1.5 meters wide and 15 meters deep. In the inland portion, the fracture is blocked by breakdown, which forms a small roofed portion, but no speleothems are present. The small fracture extends for over 6 meters and is less than 0.5 meters wide. These dissolutionally widened fractures are the result of cliff retreat associated with fracturing at the cliff margin.

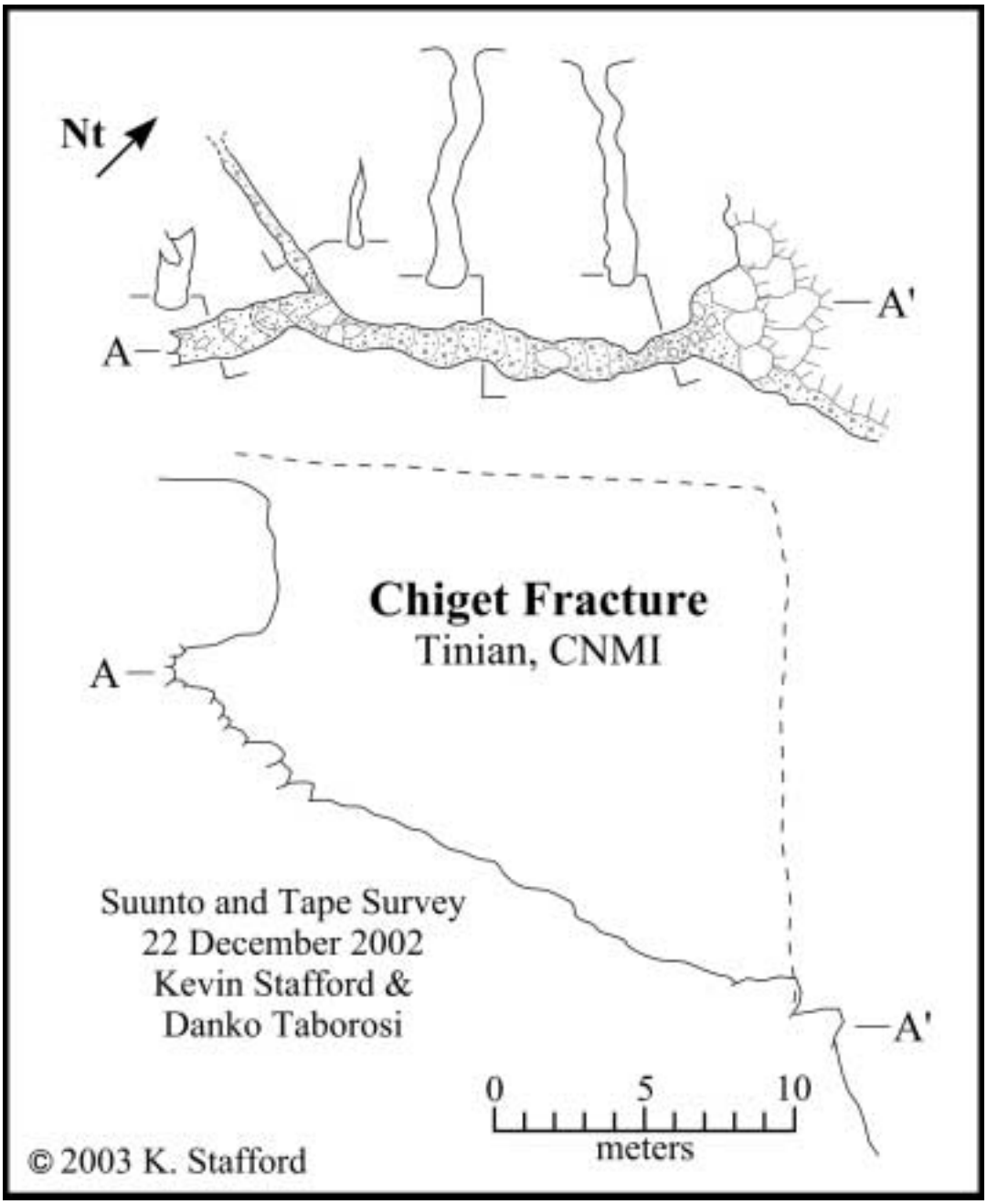

Figure 60: Map of Chiget Fracture.

Cobble Cave (Central Plateau, Tinian – Figure 61)

Cobble Cave is located 650 meters southeast of Puntan Atgidon in the Mariana Limestone (QTmu). It is a flank margin cave remnant located approximately 1 meter above sea level in the northeastern portion of a large cove referred to locally as Mendiola Cove after the landowner. The entrance is 19 meters wide and the cave extends inland 11 meters with an average ceiling height o f 4 meters. The floor is primarily composed of carbonate sand but numerous well-round cobbles and breakdown blocks are scattered around the chamber, some of which appear to be remnants of the original ceiling that extended farther seaward.

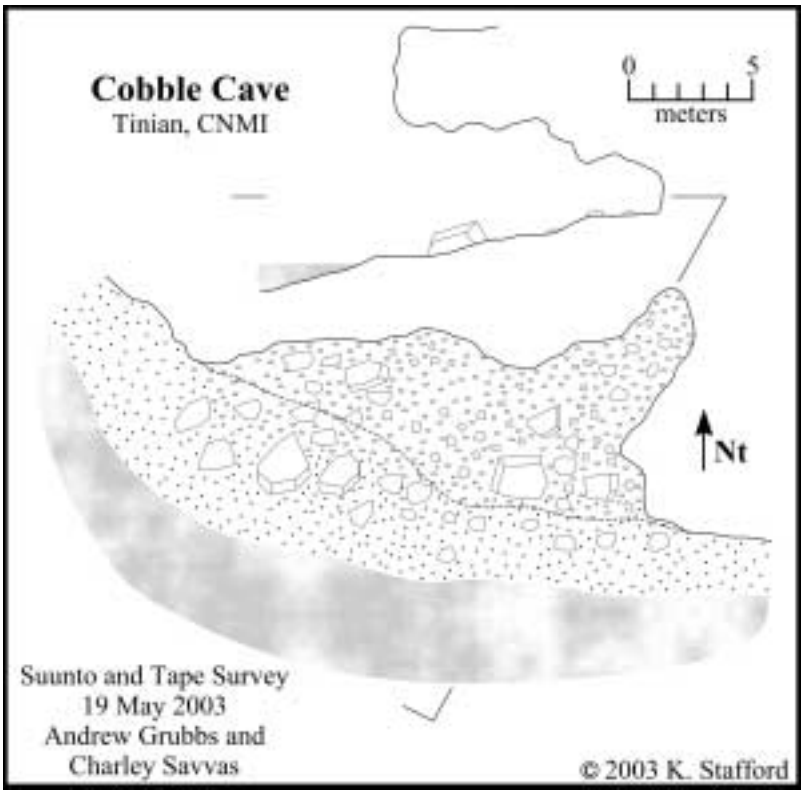

Figure 61: Map of Cobble Cave.

Coconut Trap Cave (Southeastern Ridge, Tinian – Figure 62)

Coconut Trap Cave is located in the southeastern region of the Piña ridge and developed in the Mariana Limestone (QTmu). This small, flank margin cave remnant has an entrance 5 meters wide and extends inland 5 meters with an average ceiling height of 2 meters. The cave has a small flowstone mound that partially separates the entrance area from the inland portions and has a floor composed of soil and detritus.

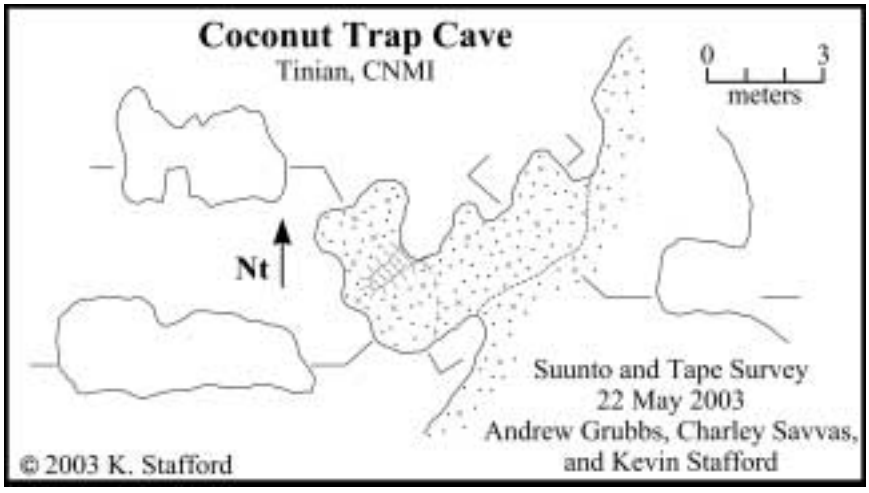

Figure 62: Map of Coconut Trap Cave.

Command Post Cave Complex (North-Central Highland – Figure 63)

The Command Post Cave Complex is located approximately150 meters north/northeast of the Lasso Shrine on Mt. Lasu. These caves, developed in the Mariana Limestone (QTmca) at the base of the cliff, appear to be breached cliff retreat. These caves were highly modified during WWII for use by the Japanese and include such features as large fortified walls across the entrances and excavated cave floors. Although the caves have been highly modified, the walls and ceiling appear to have little modification. The larger cave is approximately 19 meters by 10 meters, while the ceiling rises to 5 meters in regions. The smaller cave is approximately 4 meters by 9 meters with a ceiling height averaging 1.5 meters.

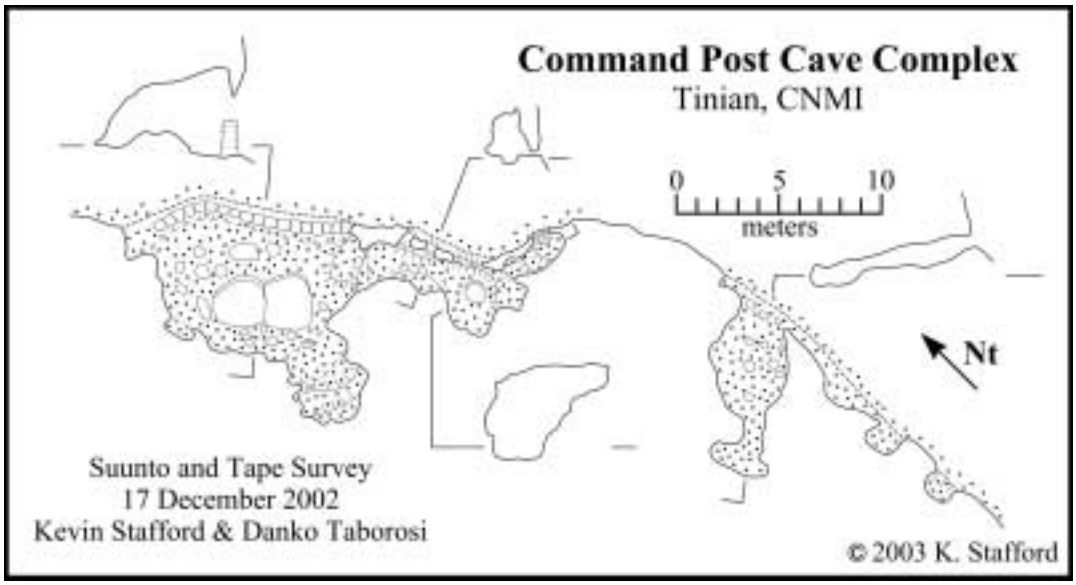

Figure 63: Map of Command Post Cave Complex.

Cowrie Cave (Central Plateau, Tinian – Figure 64)

Cowrie Cave is located approximately 500 meters southeast of Puntan Atgidon on the northern edge of a large cove locally referred to as Mendiola Cove after the landowner. This bedrock floored cave is a breached flank margin cave positioned less than 1 meter above mean sea level. The cave is 8 meters wide and 16 meters deep with a maximum ceiling height of 7 meters. A prominent fracture trends 113°, parallel to the entrance, approximately 5 meters inland and has produced 2 meter deep dissolutional features in the east and west walls of the cave. The cave is named for several large cowries that were living in a small pool of water at the time of survey.

CUC Cave (Median Valley, Tinian – Figure 65)

CUC Cave is a banana hole type cave located 500 meters east of the CUC power plant. It consists of a low broad chamber 8 by 9 meters with an average ceiling height of 1 meter. The cave contains numerous speleothem deposits primarily as stalactites and one 0.5-meter diameter column located in the middle of the feature. The floor is primarily alluvium introduced from two breached entrances; a small entrance located in the northwest corner of the feature and a larger, main entrance located in the northeast corner. The cave is located in dense vegetation on relatively flat land and is easily overlooked; however, the cave does show evidence of human modification including many broken cave formations.

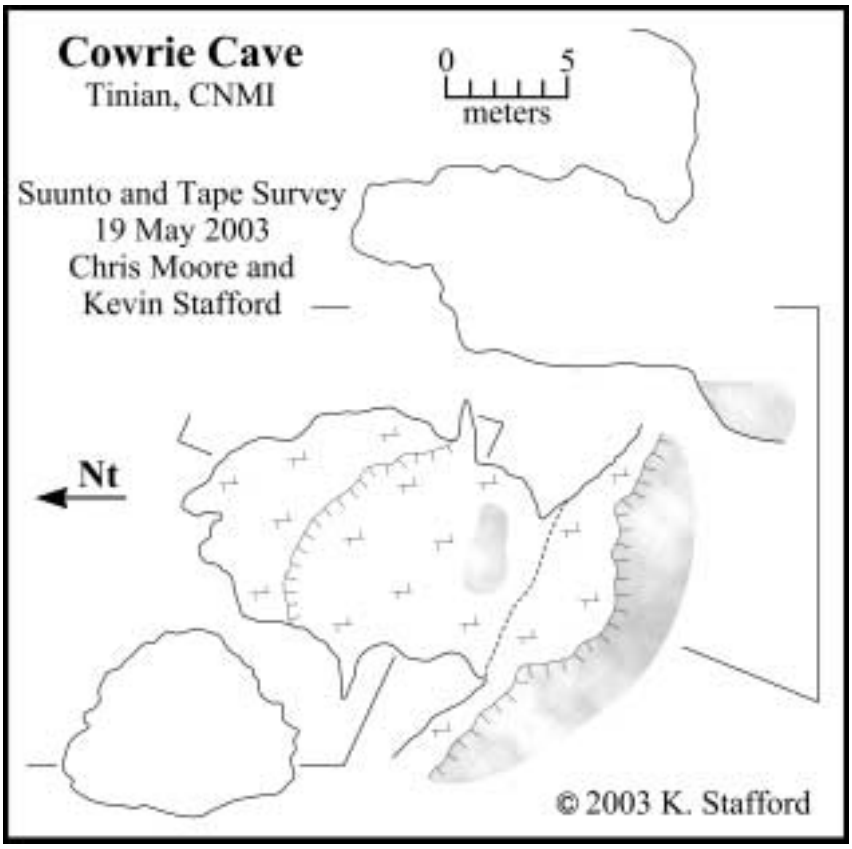

Figure 64: Map of Cowrie Cave.

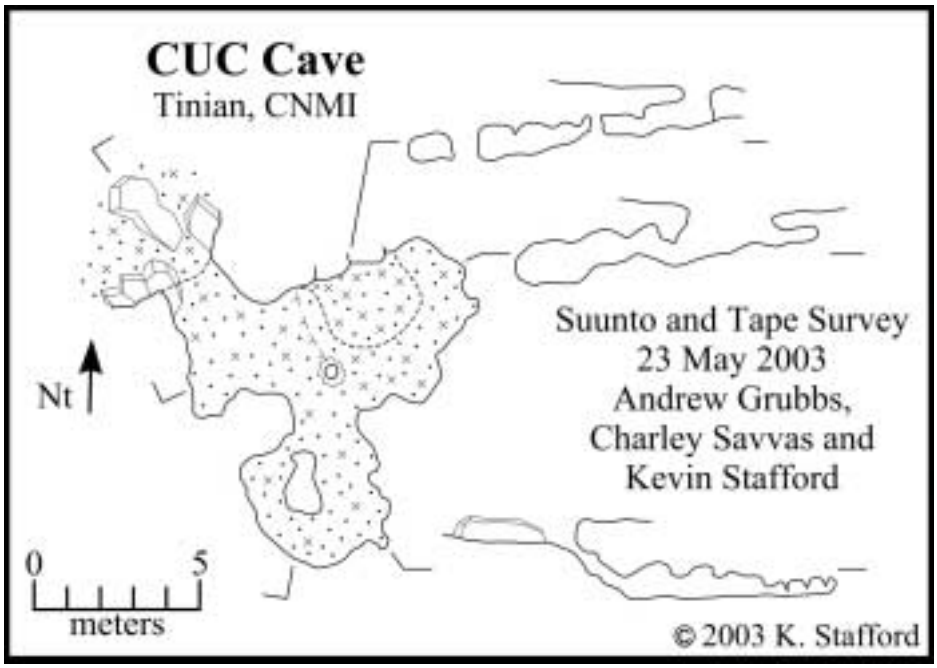

Figure 65: Map of CUC Cave.

Danko's Misery (Southeastern Ridge, Tinian – Figure 66)

Danko's Misery is located approximately 1000 meters southwest of Puntan Barangka along the northeastern cliffs of Carolina's Ridge. It is developed in the Mariana Limestone (QTmca) as a dissolutionally enhanced bank-margin fracture that is oriented northwest at a bearing of 305°. This fracture cave is 24 meters in length, 22 meters deep and has a maximum width of 2 meters. The floor is composed of breakdown, forming three levels that increase in depth to the southwest, which limited exploration. In the general region of Danko's Misery, there are numerous other fractures with the same general orientation, however most of these features are not humanly enterable.

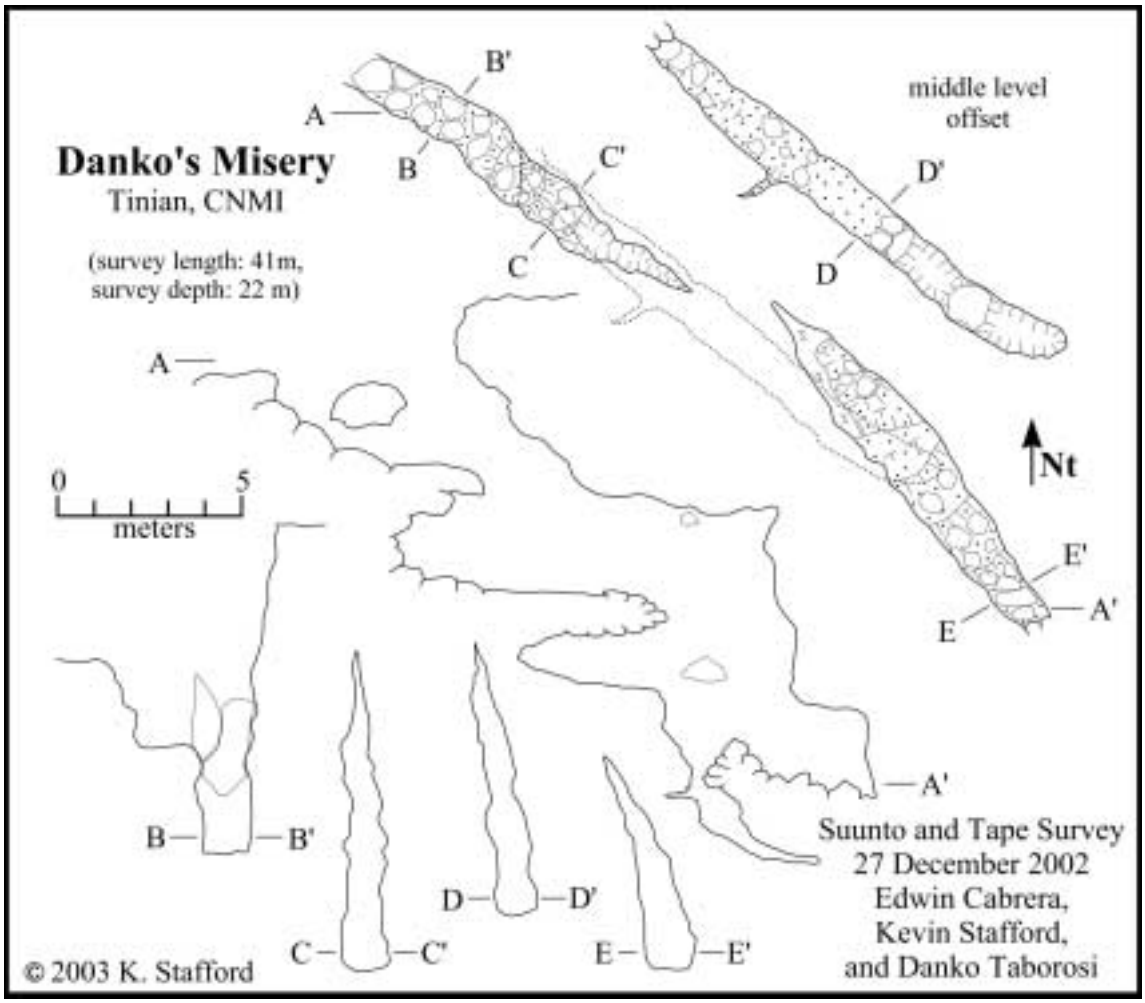

Figure 66: Map of Danko's Misery.

Death Fracture Complex (Central Plateau, Tinian – Figure 67)

The Death Fracture Complex is located along the west coast approximately 900 meters south of Puntan Diapblo in the Mariana Limestone (QTmu). This fracture complex contains three primary features, which extend inland as dissolutionally widened fractures oriented at 53°, 60°, 80°, and 112° with an average depth to sea level of 8 meters. The features are widest near the coastline and decrease in width with distance inland, however all features extend well below sea-level and are severely impacted by normal wave attack, which limited exploration to surface

observations at the time of survey. The features appear to have well-developed ledges at sea level, but the cave then appears to widen below sea level. Because of their similarity to features seen on Guam (No-Can Cave, Taborosi, 2000) and their development along prominent regional fractures, these features are interpreted as structurally controlled, fresh-water discharge features although strong surf conditions, which would surge over 4 meters upwards into the features, prevented physical observation of fresh-water discharge.

Diamond Cave (Lower Terrace, Aguijan – Figure 68)

This flank margin cave remnant is located on the southern side of Aguijan on the lower terrace in Mariana Limestone (QTmu). It extends inland (north) approximately 26 meters as two passages that are connected in the entrance area, where the ceiling height reaches a maximum of 9 meters at the entrance drip line. Extensive speleothems, including large columns, suggest that the cave was closed for period of time and was then breached by retreat of the cliff margin. This feature showed evidence of extensive use by feral goats.

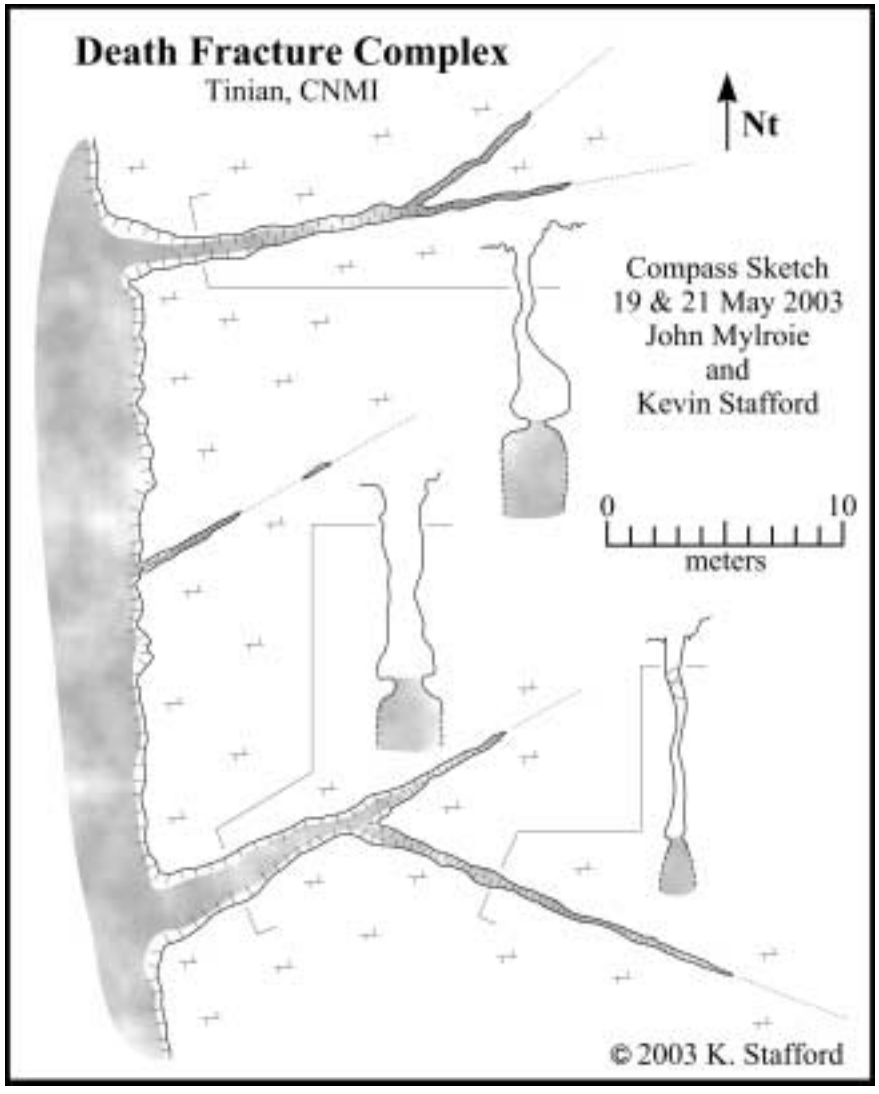

Figure 67: Map of Death Fracture Complex.

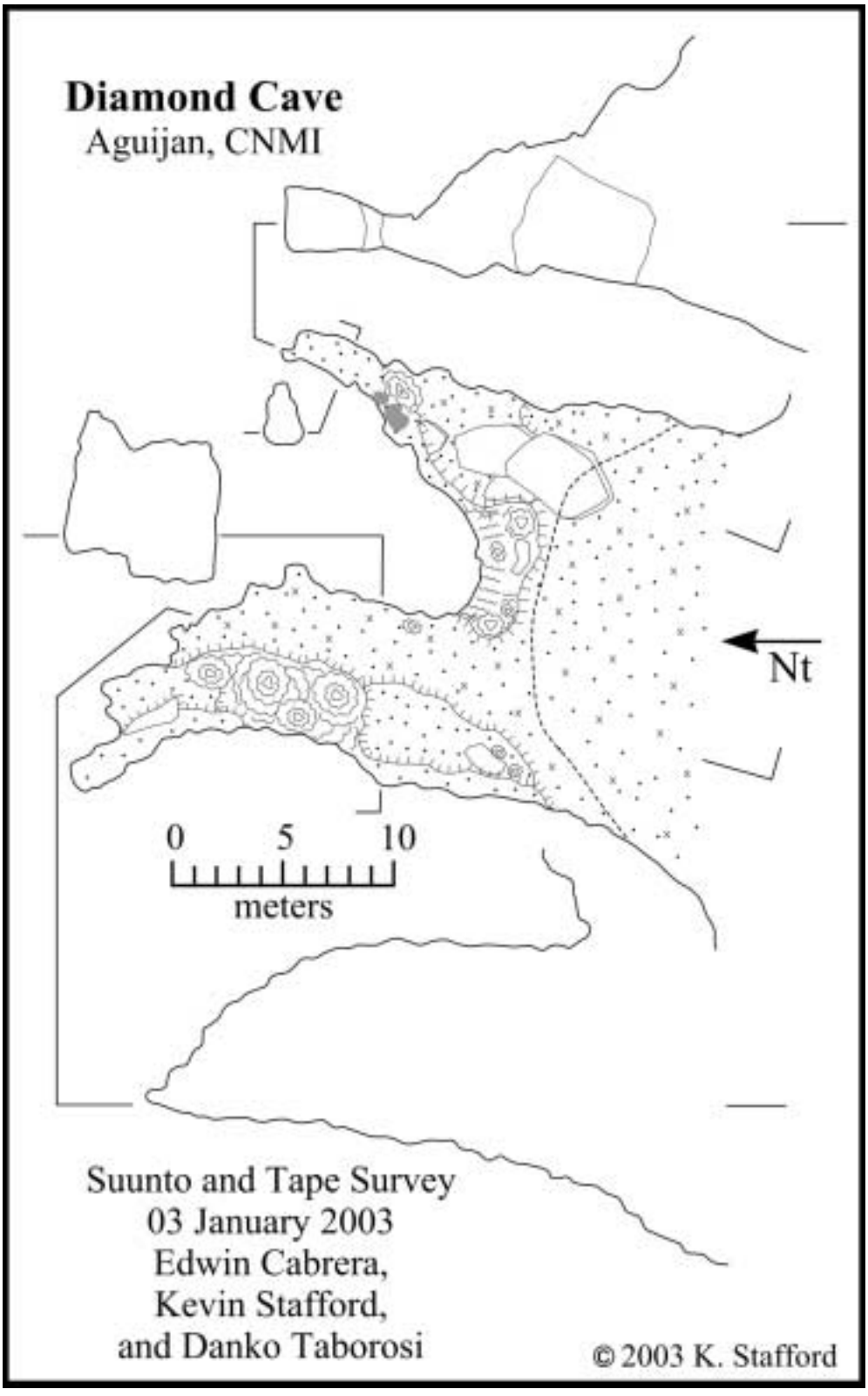

Figure 68: Map of Diamond Cave.

Dos Cenotes Cave (Central Plateau, Tinian – Figure 69)

Dos Cenotes Cave is located approximately 450 meters southeast of Puntan Atgidon in the northwest corner of a large cove locally referred to as Mendiola Cove after the landowner. The 45-meter wide, south facing entrance opens to the ocean and is protected by headlands projecting from the southeast and southwest sides. In the northeast portion, the cave extends inland 15 meters as a terraced chamber with a large bedrock column in the middle. In the northwest portion, the cave extends inland 12 meters with two bedrock columns located near the entrance. From the northwest portion of the cave, a passage averaging 3 meters wide extends to the west for 30 meters where it connects to the surface through a skylight entrance and to the ocean through a submerged passage. The cave primarily contains bedrock floors, but breakdown blocks and minor speleothem deposits are found throughout. The cave is named after two pools of water approximately 3 meters deep, which are located southwest of the main entrance area.

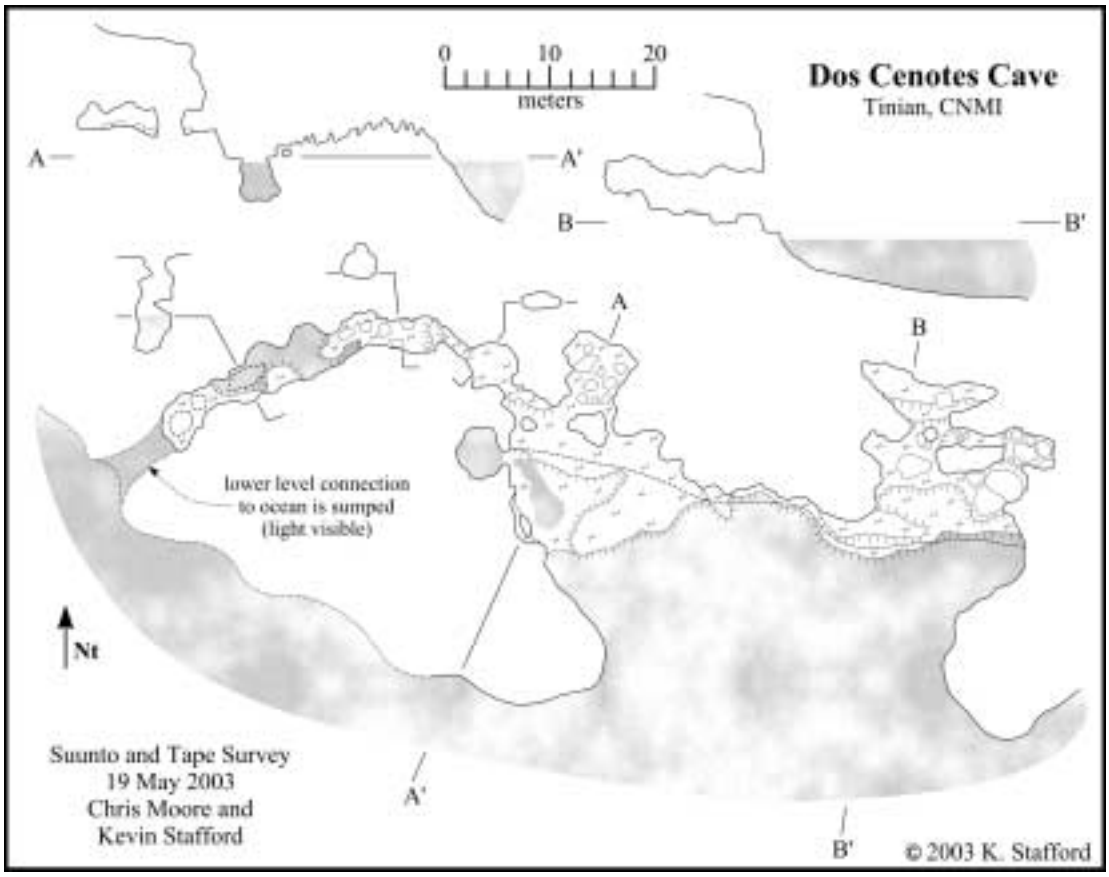

Figure 69: Map of Dos Cenotes Cave.

Dos Sakis Cave Complex (Central Plateau, Tinian – Figure 70)

Dos Sakis Cave Complex consists of five breached, flank margin caves located approximately 1000 meters east of Puntan Diapblo along a 9-meter tall scarp in the Mariana Limestone (QTmu). The caves extend inland a maximum of 5 meters with an average ceiling height of 3 meters. The most western and smallest cave in the complex is slightly elevated on the scarp wall. The two eastern most caves are simple chambers that show minor human modification including a partial rock wall. The two central caves, extend the farthest inland and show greater human modification. The western of the two has a 1-meter wide and 1-meter deep

trench extending from the entrance to the back wall of the cave. The eastern central cave is the largest and has a depression 1 to 1.5 meters deep and almost 5 meters in diameter excavated in the entrance area, while the cave floor rises 2 meters in the inland portion. The caves in this complex have floors primarily of soil and detritus with occasional breakdown blocks and all appear to have been partially to extensively modified by humans.

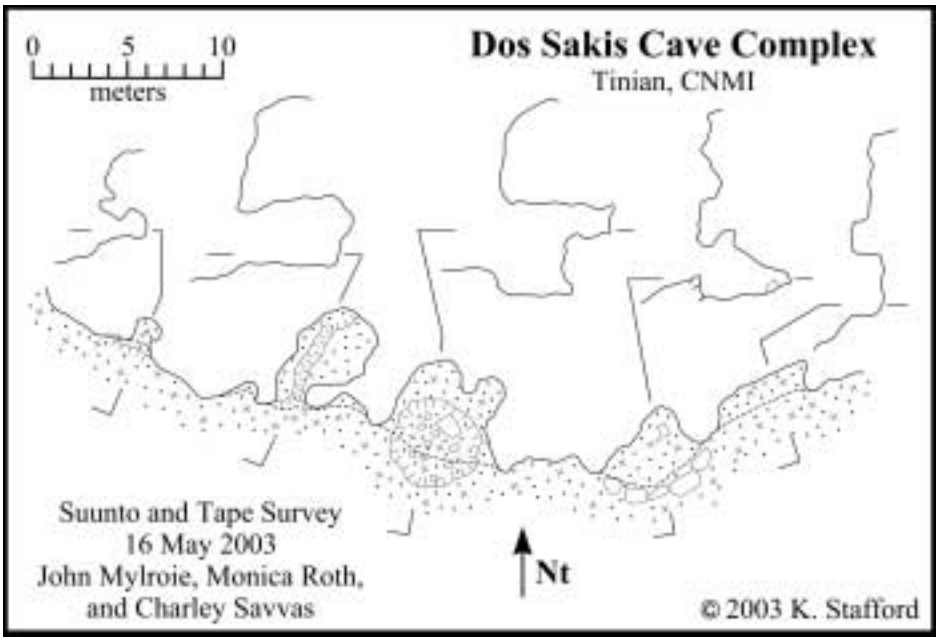

Figure 70: Map of Dos Sakis Cave Complex.

Dove Cave (Upper Terrace, Aguijan – Figure 71)

Dove Cave is a small banana hole type cave located in the northwest portion of the Upper Terrace in the Mariana Limestone (QTmu). It has a maximum width of 6 meters and an average height of 1 meter, with a floor primarily composed of alluvium and detritus. In the northeast portion of the cave, a flowstone mound is present which is 1 meter by 2 meters and rises 0.5 meters above the floor level of the cave. The entrance is located on the southern side of the feature in a region composed of breakdown blocks, which partially conceal the entrance.

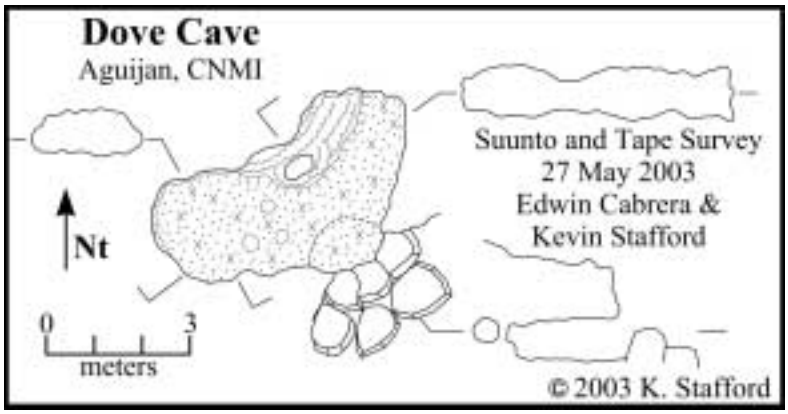

Figure 71: Map of Dove Cave.

Dripping Tree Fracture Cave (Median Valley, Tinian – Figure 72)
Dripping Tree Fracture Cave, developed in the Mariana Limestone (QTmca), is located approximately 200 meters south of Unai Dangkolo and consists of a long fracture oriented approximately 335°. The feature was mapped for almost 300 meters with several small fractures intersecting it at high angles. The majority of the feature is unroofed, but two sections, each approximately 20 meters long, have roofs composed of large breakdown blocks. The feature has been formed by solutional modifications of a bank-margin failure crack. It is up to 5 meters wide and greater than 16 meters deep, with depth varying greatly depending on the amount of breakdown and alluvium present. Throughout the feature, speleothems are present, with larger accumulations present in the roofed portions. At the deepest part of the feature, the southern end, there is a segment containing 1.5-meter deep brackish water. Although no direct connection was discovered to the ocean in this part of the feature, the presence of marine fauna indicates there must be some connection. In the northern portion of the feature, where it connects directly to the ocean, a Japanese pillbox was constructed approximately 6 meters above sea level.

Immediately inland from Dripping Tree, there are several smaller fractures that are not humanly accessible. They are formed parallel to the main fracture, resulting from the inland migration of cliff margin retreat. These features show less dissolutional enhancement than that seen in Dripping Tree Fracture Cave.

Dump Coke Cave (Central Plateau, Tinian – Figure 73)

Dump Coke Cave is located 700 meters south/southeast of Puntan Lamanibot Sanhilo in Lamanibot Cove, which is locally referred to as Dump Coke because of the numerous soda bottles that were disposed of there during World War II. This breached flank margin cave, which extends inland 21 meters with and entrance width of 6 meters, is developed in the Mariana Limestone (QTmu). The cave has a maximum ceiling height of 11 meters and a floor covered in heavily weathered breakdown blocks. From the inland portion of the main chamber, a small, tube-like passage extends inland 4 meters and turns abruptly north for and additional 3 meters before terminating. This tube is 3 meters above the floor of the main chamber and has a bedrock floor for the majority of its length.

Dynasty Cave (Median Valley, Tinian – Figure 74)

Dynasty Cave is a breached flank margin cave located 100 meters north of Taga Beach in the Mariana Limestone (QTmu). The cave is 12 meters wide at the entrance and extends inland 15 meters with an entrance ceiling height of 3 meters. The majority of the cave floor is slightly below sea level, while the inland portions consist of a bedrock ledge 2 meters above the main floor. Several large breakdown blocks are located in the entrance area and appear to be pieces of the original roof. These breakdown blocks originally extended further seaward but have now been transported slightly inland by intense wave action.

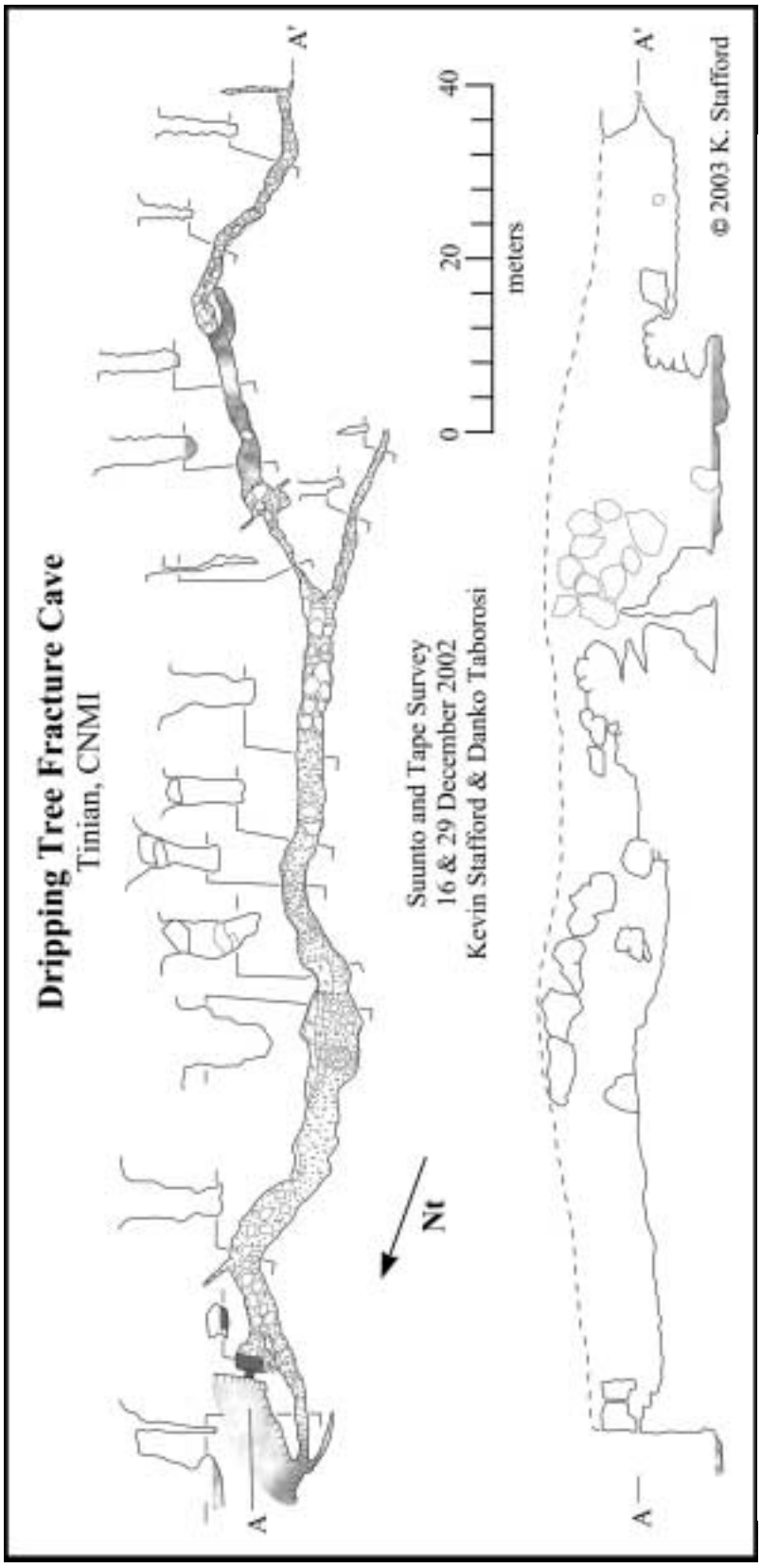

Figure 72: Map of Dripping Tree Fracture Cave.

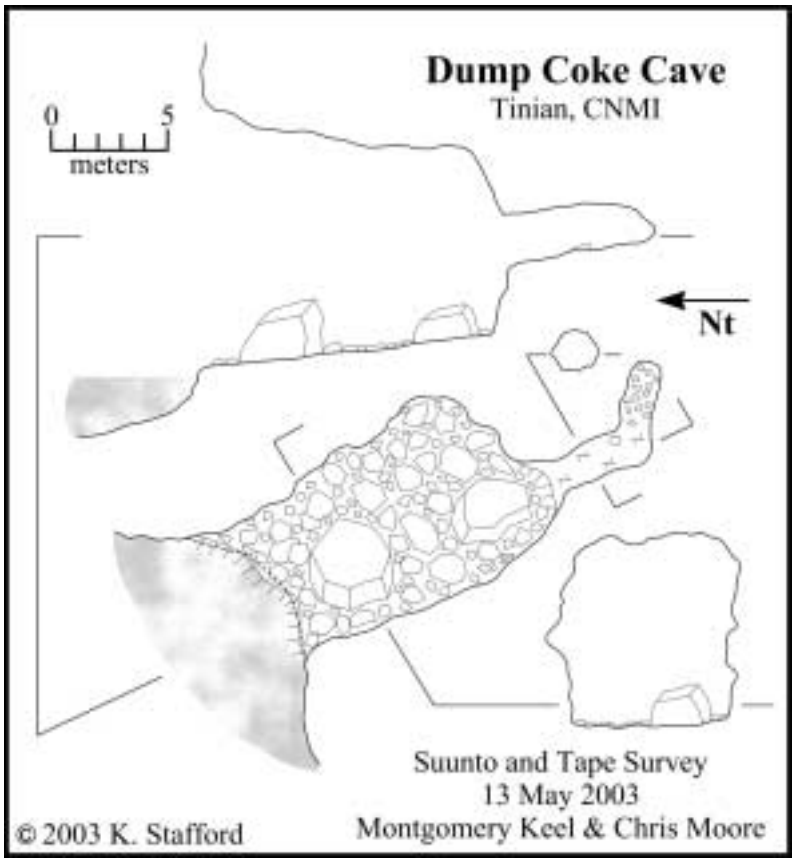

Figure 73: Map of Dump Coke Cave.

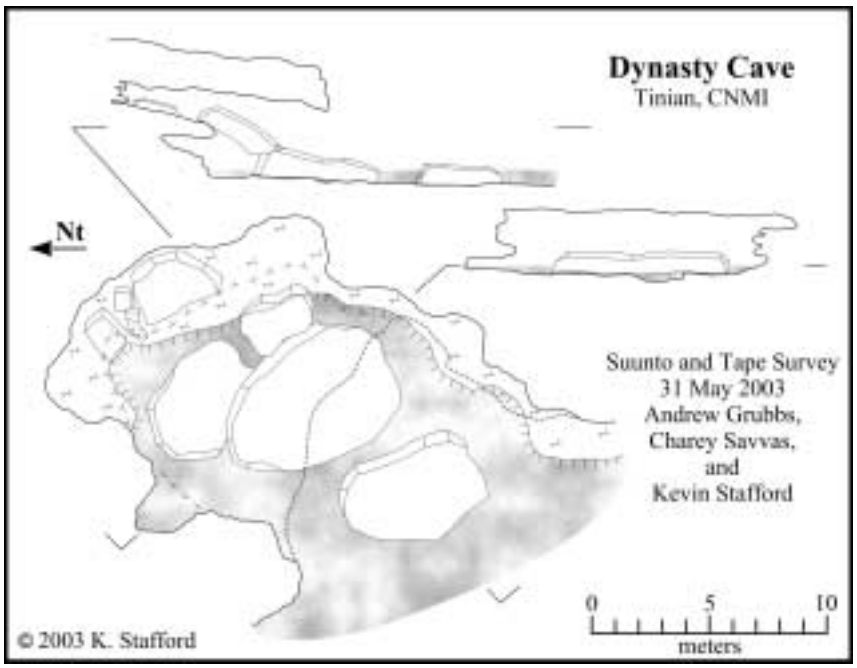

Figure 74: Map of Dynasty Cave.

East Suicide Cliff Cave (Southeastern Ridge, Tinian – Figure 75)

East Suicide Cliff Cave, a breach flank margin cave at the far eastern portion of Suicide Cliffs, was originally named Suicide Cliff Cave #1 (Stafford et al., 2002). This feature, developed in the Mariana Limestone (QTmu), contains several entrances, including a ceiling entrance. The feature is 20 meters wide and extends inland for 6 meters with a maximum ceiling height of 7 meters. The feature has some speleothems and has been modified by humans, including the construction of a partial rock wall across the two largest entrances in the eastern portions of the cave. The main chamber descends approximately 2 meters through a small passage to the north, where it connects to a second smaller chamber breached along the cliff.

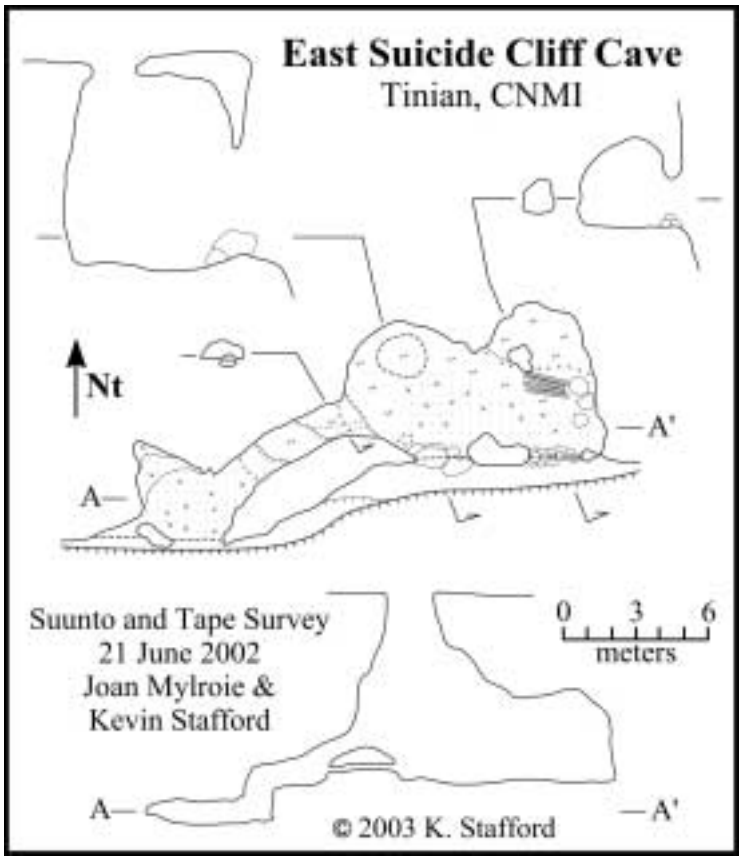

Figure 75: Map of East Suicide Cliff Cave.

Edwin's Ranch Cave (Central Plateau, Tinian – Figure 76)

Edwin's Ranch Cave is located approximately 1200 meters south of Unai Lamanibot and approximately 800 meters east of the coastline. This flank margin cave is developed in the Mariana Limestone (QTmcc) and has been breached by cliff retreat. The cave appears to be nearly complete, with 3 small entrances that are less than 1 meter high on the northern margin of the cave. The cave is 3 meters tall, 9 meters wide and 12 meters long. In the southeast portion of the cave, there are two small side chambers, while the entrances appear to be similar features that were breached. Speleothems in the cave are limited and the floor is composed primarily of alluvium of indeterminate depth. The two northwest entrances show evidence of human excavation, which makes access into the feature possible, but the northeast entrance has not been modified and is less than 10 centimeters tall.

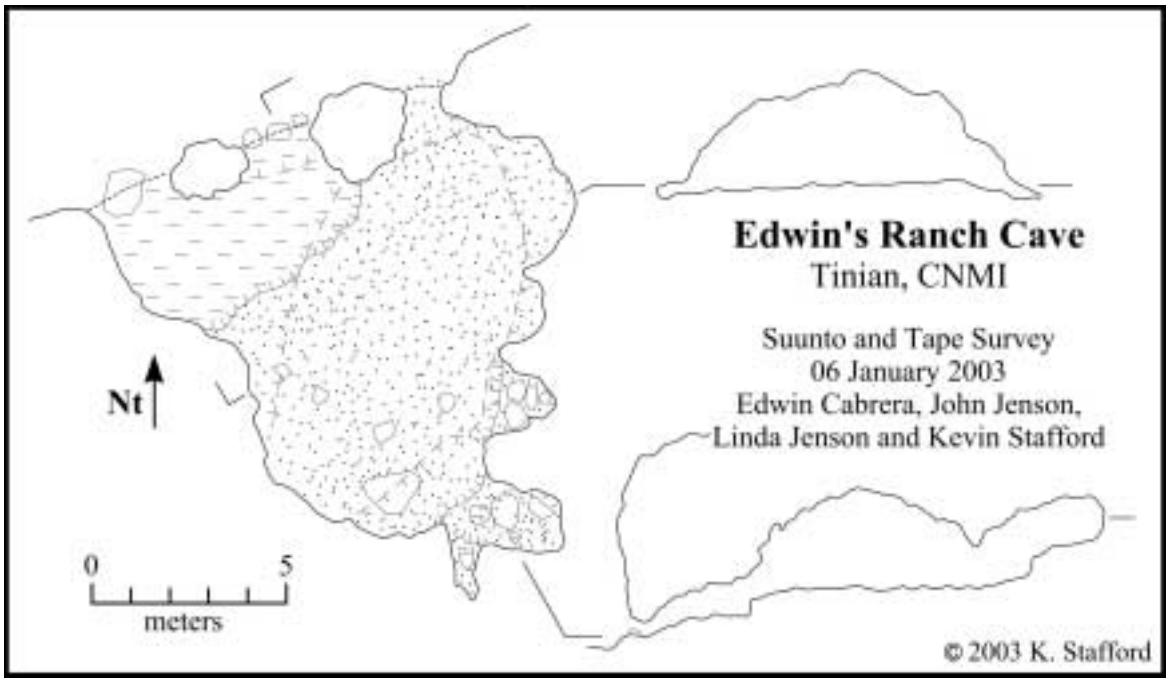

Figure 76: Map of Edwin's Ranch Cave.

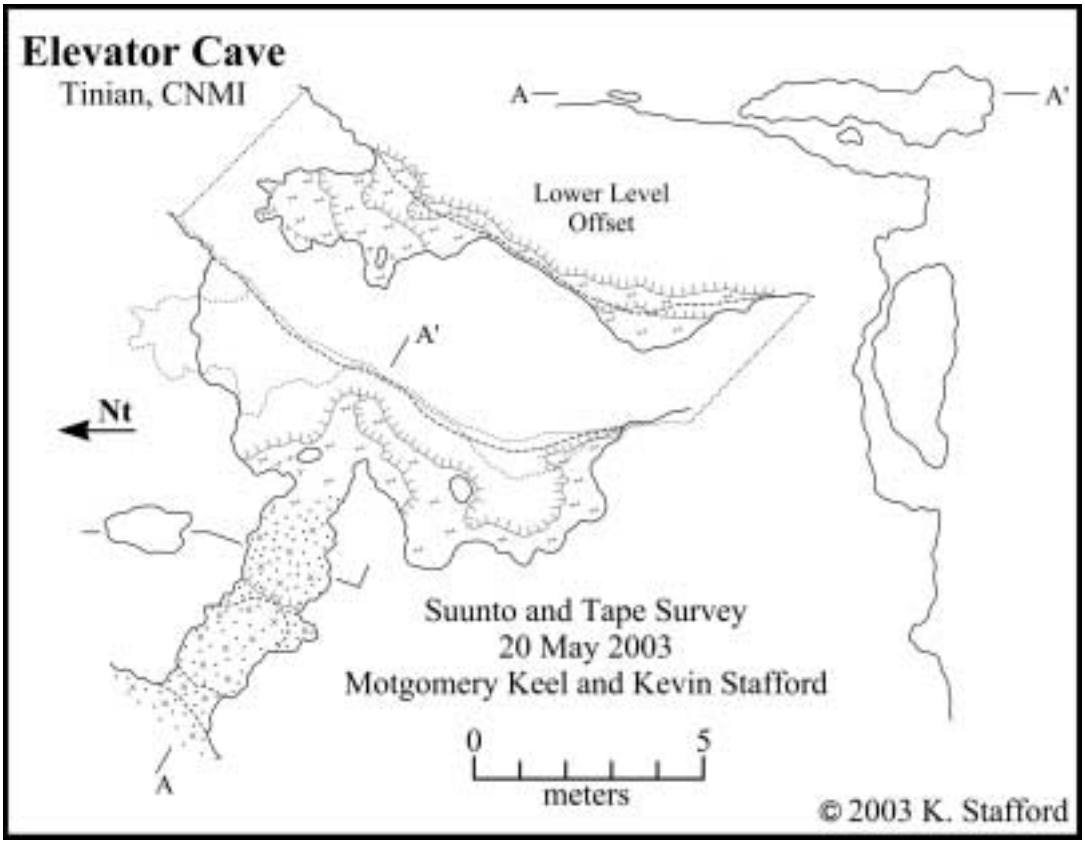

Figure 77: Map of Elevator Cave.

Elevator Cave (Southeastern Ridge, Tinian – Figure 77)

Elevator Cave is located in the central region of Suicide Cliffs in the Mariana Limestone (QTmu). This flank margin cave, composed of two distinct levels, has been breached by cliff retreat on the southeastern side and by roof collapse on the northwestern side. The upper level contains the two mentioned entrances with a cliffside width of 9 meters which narrows to 2 meters wide 3 meters inland where it continues for an additional 7 meters through a passage 1.5 meters tall. The lower level is 7 meters below the upper level and exhibits a similar entrance width, but extends inland only 3 meters. The two levels are connected by a series of small ledges, while the floor throughout is primarily bedrock with alluvium in the area near the collapsed roof entrance. The cave was named for its vertical extent, which is greater than most caves observed at Suicide Cliffs.

False Floor Cave (Southeastern Ridge, Tinian – Figure 78)

False Floor Cave is located in the southeastern region of the Piña ridge in the Mariana Limestone (QTmu). The cave is widest at the entrance (17 meters) and extends inland as two chambers. The south chamber extends inland 4 meters with a chamber 6 meters wide and a partial rock wall in the entrance area. The northern, larger chamber extends inland 9 meters and has been significantly modified by humans, including a large rock walled terrace that is 3 meters inland and 2 meters wide and a 1-meter deep excavated area covered by a deteriorating wooden floor. The majority of the cave is floored with soil and detritus with bedrock floors in the most interior regions of the northern chamber.

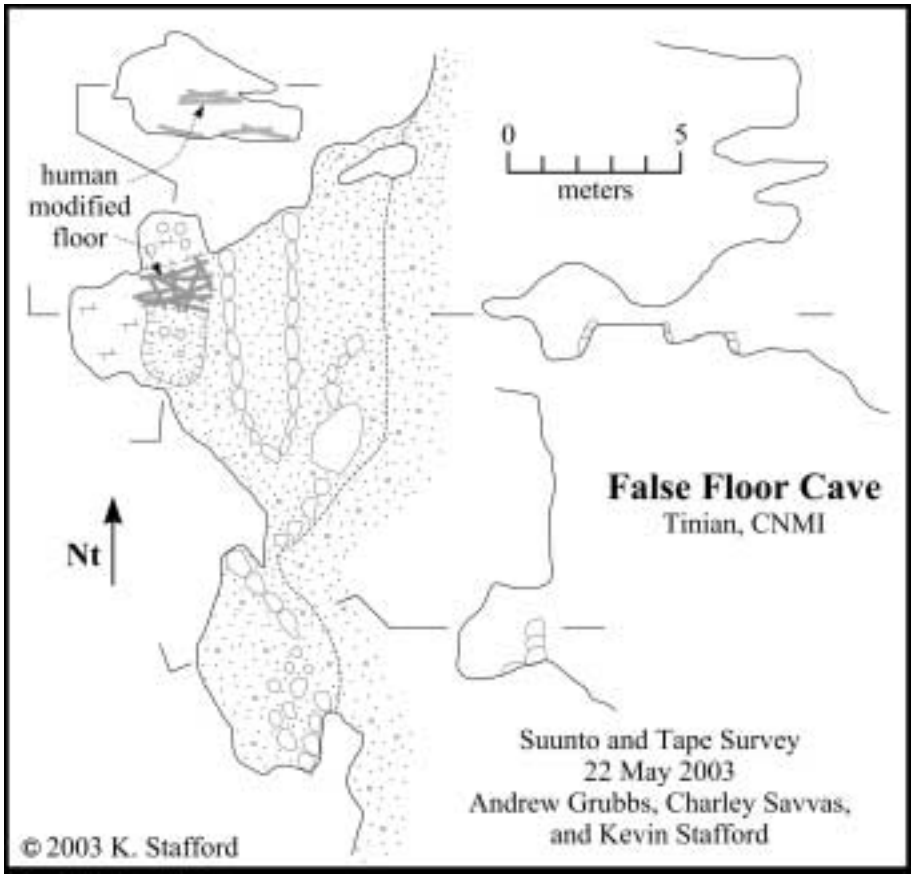

Figure 78: Map of False Floor Cave.

Five Bee Cave Complex (Southeastern Ridge, Tinian – Figure 79)

Five Bee Cave Complex is located 1900 meters southwest of Puntan Barangka on the north side of the Carolinas ridge in the Mariana Limestone (QTmc). This cave complex is consists of two flank margin remnants and a prominent notch in the scarp that is 12 meters wide and 10 meters deep. The notch contains two dissolutionally widened fractures in the northeast and southeast corners that define the notch boundaries. The cave remnant north of the notch extends inland 6 meters as two small partial chambers, while the southern remnant extends inland only 2 meters but has flowstone deposits on the inner wall. The entire complex is 40 meters long and has a soil floor throughout.

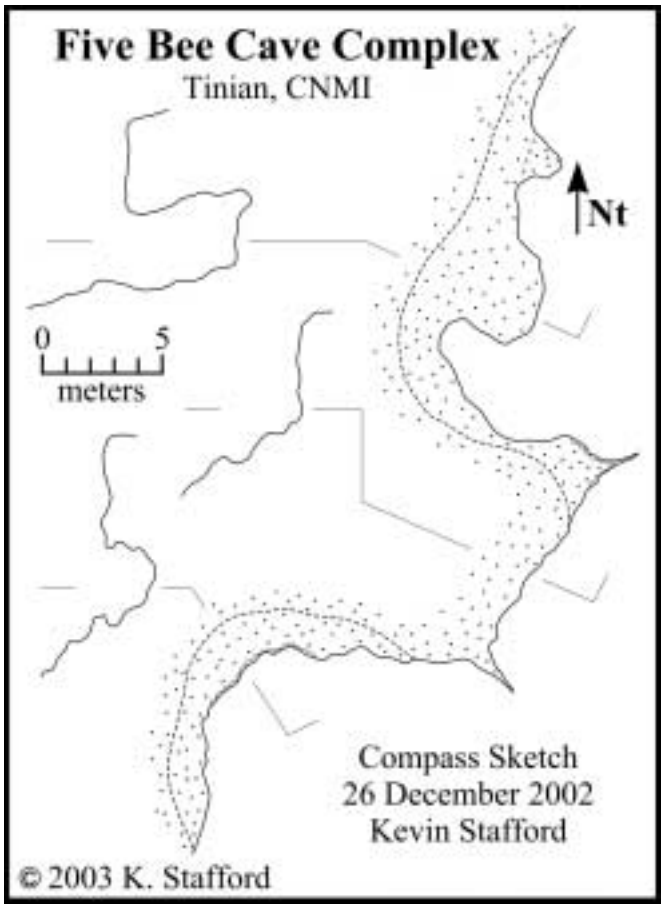

Figure 79: Map of Five Bee Cave Complex.

Flamingo Tail Caves (Central Plateau, Tinian – Figure 80)

Flamingo Tail Caves are located 900 meters west/southwest of Puntan Diapblo along a small intermittent scarp in the Mariana Limestone (QTmu). This section of scarp contains two caves and a series of well-defined notches that may represent other flank margin cave remnants where the ceiling has completely collapsed. The eastern portion of the scarp segment contains a cave with three distinct passages, averaging 2 meters in height that radiate from a central entrance area; one extends east 8 meters, one extends northeast 7 meters and one extends north 4 meters. On the western edge of the scarp segment, a small remnant cave extends inland 2 meters with a width of 4 meters and height of 0.5 meters. The ground surface along the scarp and inside the caves is composed of soil and detritus with some minor breakdown blocks in the eastern cave.

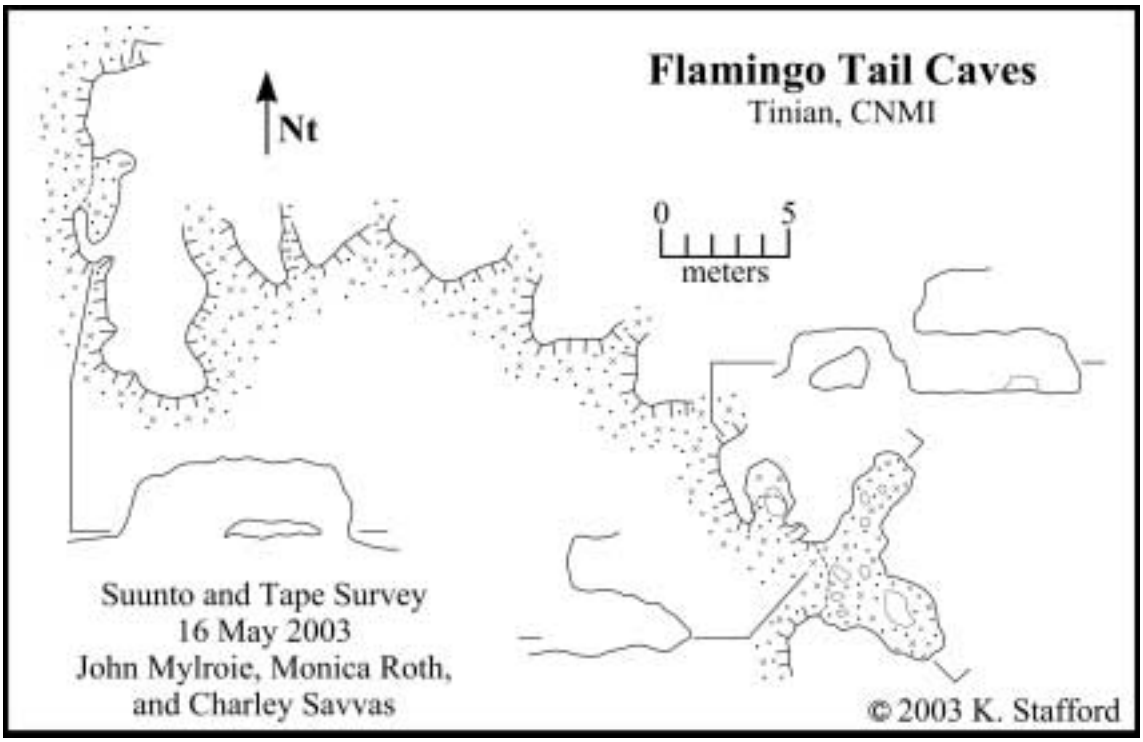

Figure 80: Map of Flamingo Tail Caves.

Fleming Point Cave (Central Plateau, Tinian – Figure 81)

Fleming Point Cave is located 700 meters north/northeast of Puntan Atgidon in a small cove developed in the Mariana Limestone (QTmu). The cave is developed along a prominent fracture or joint that is well defined in the ceiling and floor of the cave throughout the 41 meters that the cave extends inland. The cave has an entrance height of 11 meters and decreases to 6 meters, 13 meters inland from the entrance. The cave has two prominent dissolutional pockets that deviate from its linear passage; one located on the east side at 9 meters inland and one on the west side at 22 meters inland. The cave is primarily bedrock floored, but contains some large breakdown blocks in the inland portions. Based on the general morphology of the cave, its development along a prominent zone of brittle failure and observable scheiren mixing of the water near the entrance, this feature is interpreted as a structurally controlled discharge feature.

Full Bottle Cave (Southeastern Ridge, Tinian – Figure 82)

Full Bottle Cave is located approximately 500 meters west/northwest of Puntan Masalok in the Mariana Limestone (QTmu). It is developed along a fracture, oriented northwest (~310^{o}) and dipping to the northeast at approximately 60^{o}. The feature is 6 meters deep and up to 6 meters wide. The main chamber extends for 14 meters, but fractures less than 20 centimeters wide extend beyond the main chamber in northwest and southeast directions. The floor is primarily composed of breakdown with indications that the fracture extends to greater depths. Speleothems are primarily concentrated on the southwest wall of the chamber, on the footwall of the fracture. The entrance is located in the southwest portion of the feature amongst numerous breakdown blocks in the northern region of the "600 Meter" Fracture System.

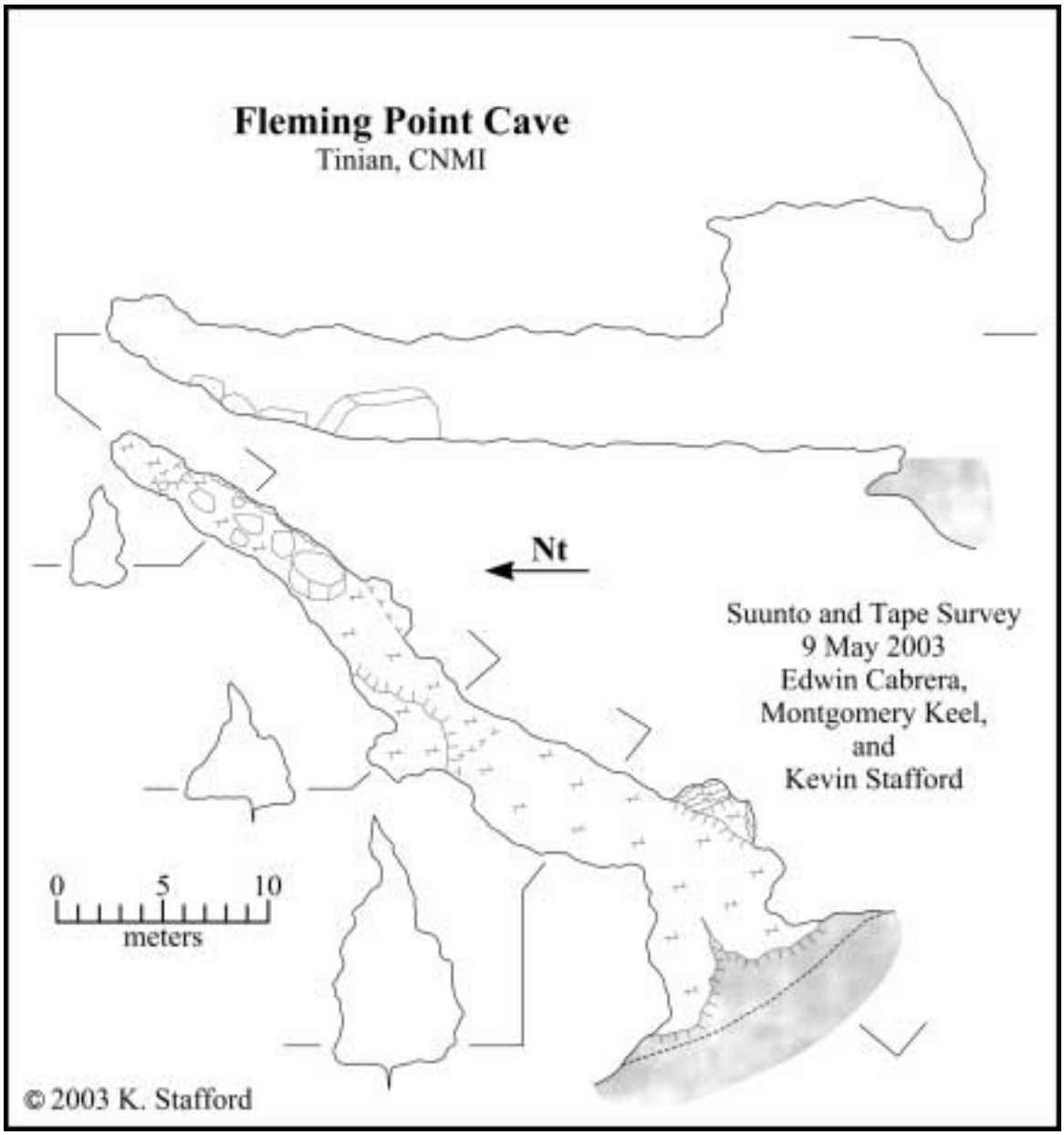

Figure 81: Map of Fleming Point Cave.

Gecko Cave (Median Valley, Tinian – Figure 83)

Gecko Cave is located approximately 200 meters southeast of Unai Masalok on the coastline at sea level. It is developed in the Mariana Limestone (QTmu) and discharges freshwater through a tubular passage. It is developed along a dissolutionally enhanced joint oriented at approximately 60°, which extends inland for more than 20 meters from a small coastal bay. Directly south of Gecko Cave is another feature that extends inland a similar distance, but is mostly water-filled, such that during exploration it could not be surveyed because of strong surf conditions. A freshwater discharge rate could not be calculated within in the cave for similar reasons, but significant fresh water could be observed mixing with saltwater inside the cave.

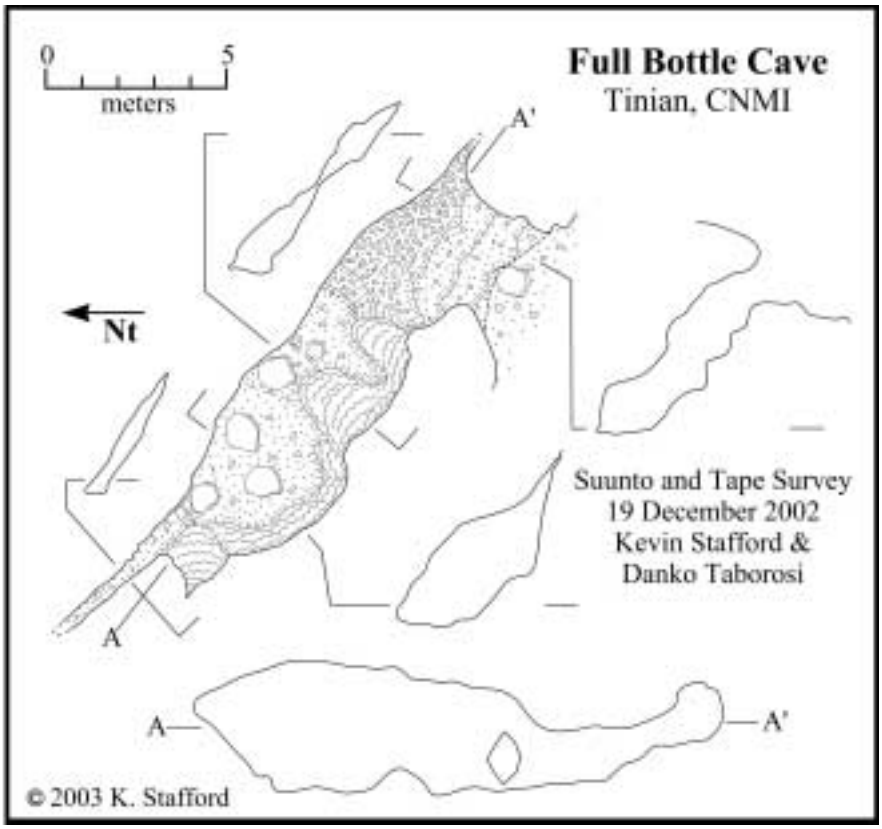

Figure 82: Map of Full Bottle Cave.

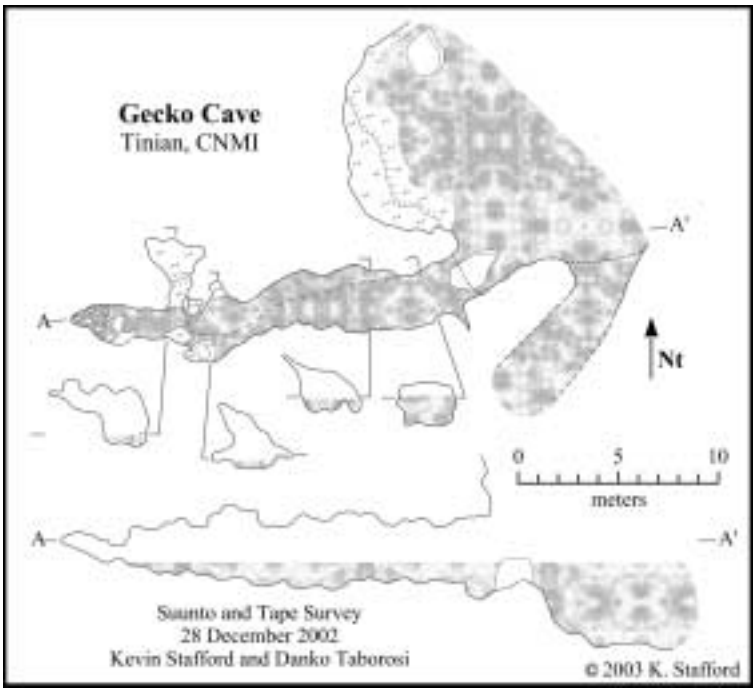

Figure 83: Map of Gecko Cave.

Goat Cave (Lower Terrace, Aguijan – Figure 84)

Goat Cave is developed in the Tagpochau Limestone (Tt) and represents a remnant of a large flank margin cave that has been intersected by cliff retreat along the southern cliff that separates the Lower Terrace and Middle Terrace of Aguijan. The feature is semicircular, with a width of 33 meters at the entrance and extending inland (north) for 16 meters with a ceiling height of approximately 14 meters. Just east of the center of the cave is an elevated bedrock area mantled by speleothems including several large stalagmites 3 meters tall. Minor roof collapse has occurred throughout the cave, but it primarily retains its dissolutional morphology. Throughout the cave extensive evidence of occupation by feral goats is found on the thin alluvium layer that covers the majority of the floor.

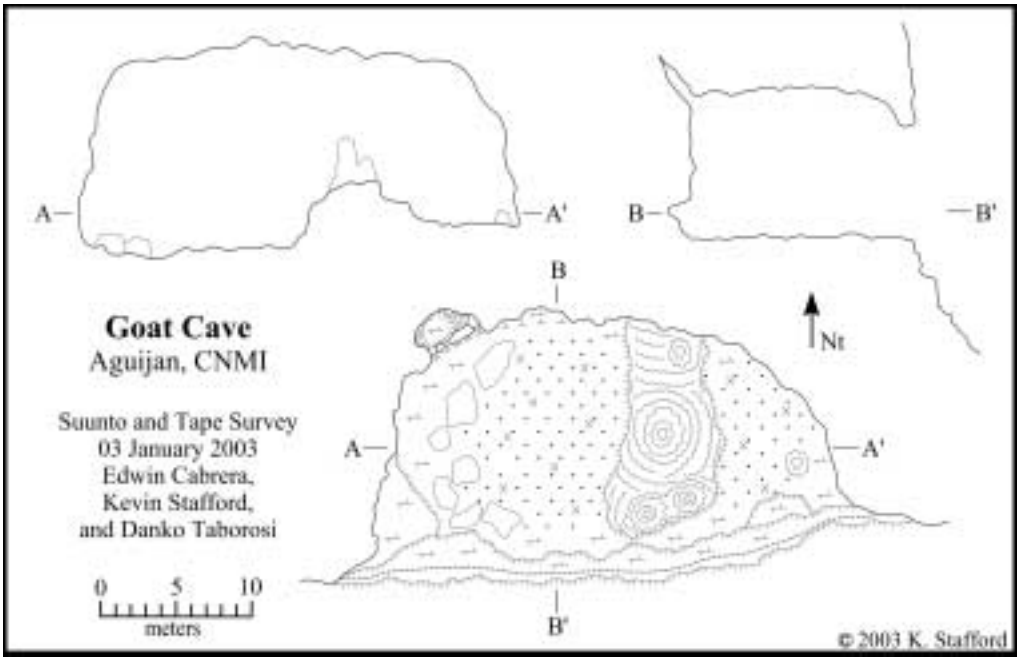

Figure 84: Map of Goat Cave.

Goat Fracture Cave (Lower Terrace, Aguijan – Figure 85)

Goat Fracture Cave is a large fracture oriented at 15°, which has two small, roofed portions. The feature is located in the northwest region of the Lower Terrace in the Mariana Limestone (QTmu). It averages 3 meters wide and generally extends 3 to 5 meters below the land surface with a floor composed primarily of breakdown blocks. Minor speleothem deposits are seen along the walls of the feature indicating that it was partially covered in the past. The feature continues for approximately 100 meters to the coast and for a shorter distance inland, but only the roofed portions were surveyed due to time constraints at the time of exploration. The feature appears to be associated with bank-margin failure, but has been modified by dissolution and collapse.

Half-Dozen Cave (Central Plateau, Tinian – Figure 86)

Half-Dozen Cave is a breached flank margin cave located approximately 2 kilometers east of Puntan Diapblo and approximately 300 meters north of the coast. It is developed in the Mariana Limestone (QTmu) and appears to have been infilled with limestone aggregate. The cave is entered at the top of a scree slope along the cliff edge, which forms an angle of

approximately 35° to the cliff and descends at a 35° slope into the cave near the cave's roof. The cave is 8 meters long and 7 meters wide with some minor speleothems in interior portions and exterior cliff wall. The feature is thought to be more extensive based on the occurrence of additional speleothems on the cliff wall, but much of the entrance appears to be currently blocked by the loose aggregate.

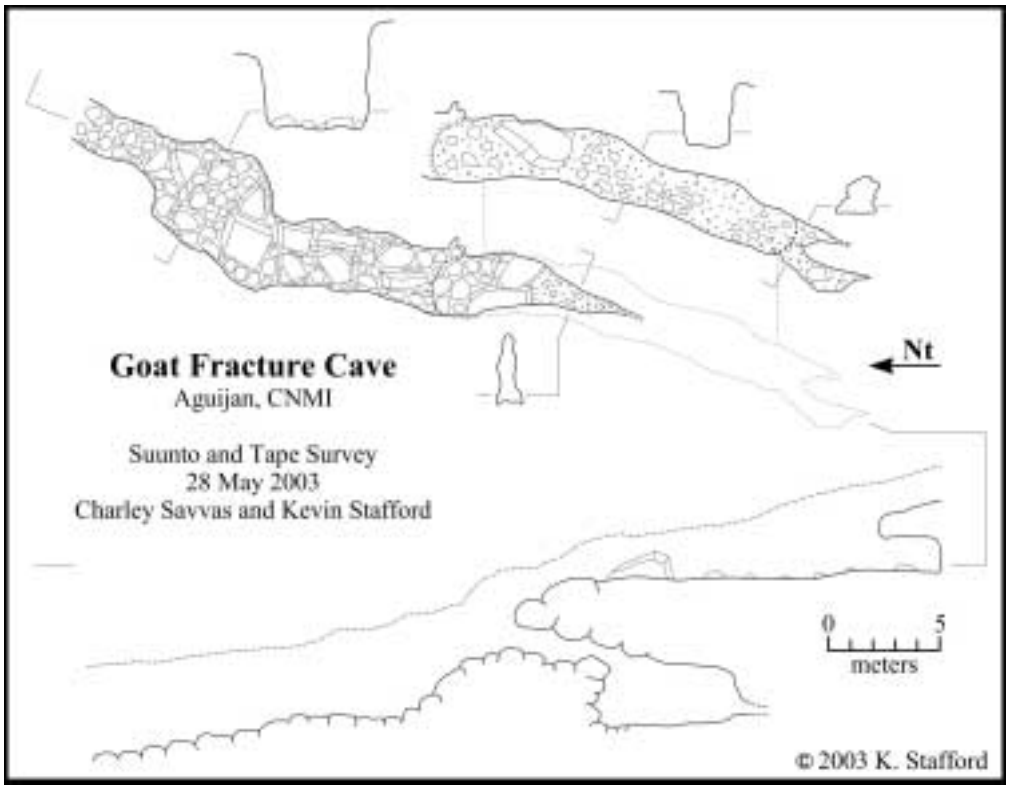

Figure 85: Map of Goat Fracture Cave.

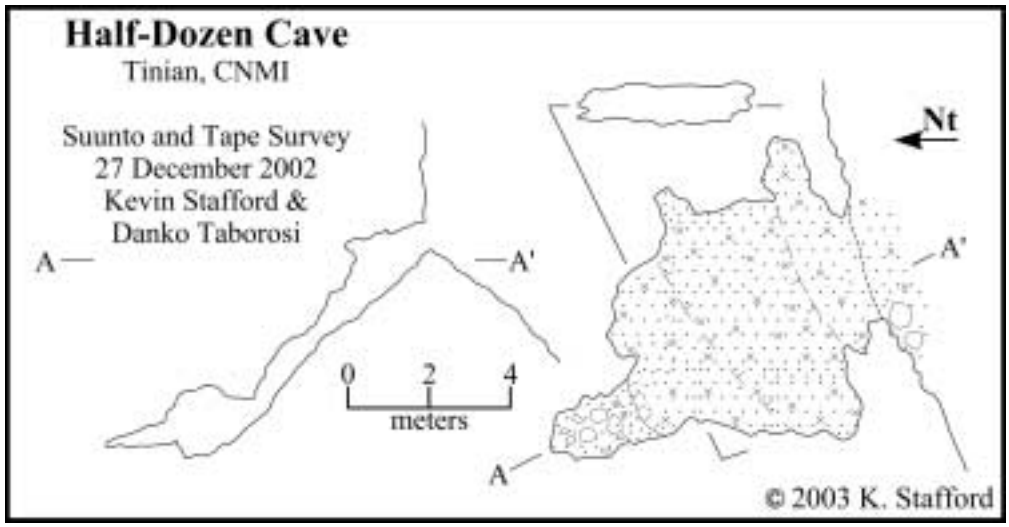

Figure 86: Map of Half-Dozen Cave.

Headless Tourist Pit (Southeastern Ridge, Tinian – Figure 87)

Headless Tourist Pit, developed in the Mariana Limestone (QTmu), is located approximately 500 meters east of Puntan Carolinas, 6 meters from the coastal cliff. The feature is on the coastal terrace, which has extensive phytokarst development. It is approximately 3 by 5 meters in diameter at the entrance and narrows to 0.5 by 3 meters at a depth of 10 meters, before widening into a joint controlled collapse chamber, which forms a littoral cave that connects to the ocean approximately 5 meters above the coastal bioerosion notch. The upper portions of the pit exhibit phytokarst development and collapse, while the restricted middle region contains minor secondary deposits. The lower chamber, which connects to the ocean, is approximately 8 meters wide and 15 meters long, with joints extending to the northeast and northwest. This feature is evidence of pit formation acting as vadose fast flow routes on the island of Tinian. Although it does not provide fast flow recharge to the aquifer, because of its direct connection to the ocean, it does demonstrate the presence of pits on Tinian.

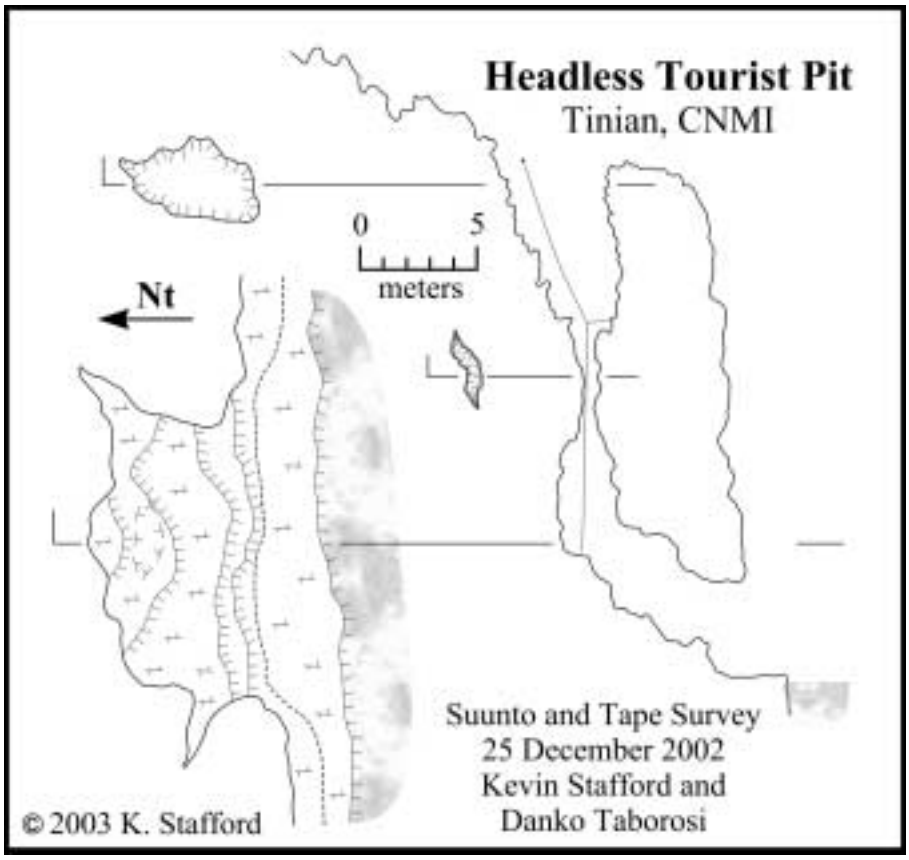

Figure 87: Map of Headless Tourist Pit.

Hermit Crab Cave (Southeastern Ridge, Tinian – Figure 88)

Hermit Crab Cave is located in the southeast region of the Piña ridge in the Mariana Limestone (QTmu). It is a small, flank margin cave remnant developed 6 meters above the base of the scarp extending inland 6 meters with an average height of 3 meters. The floor is composed of detritus and soil with a prominent mound located in the middle of the 2.5 meter wide passage. The cave, which contained several hermit crabs at the time of survey, is easily reached by a short climb.

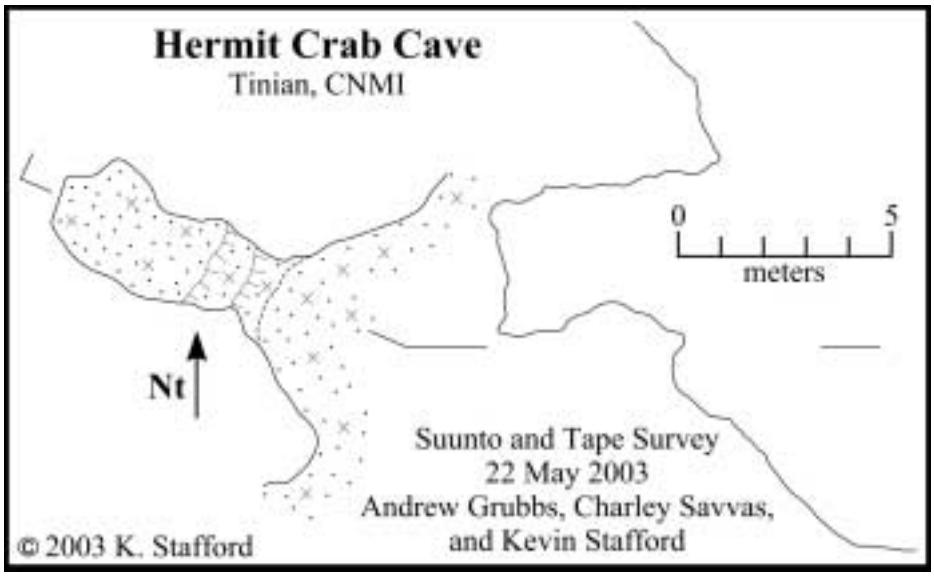

Figure 88: Map of Hermit Crab Cave.

Hidden Beach Cave (Median Valley, Tinian – Figure 89)

Hidden Beach is located at Unai Asiga, 1000 meters north of Unai Dangkolo, on the east coast. It is developed in the Mariana Limestone (QTmca) and extends inland 80 meters with an average width of 11 meters, but the majority of the ceiling is absent. The entrance is located at sea level and has a carbonate sand floor sloping gently inland. The cave has several small passages that extend from the north and south sides of this east/west trending feature, but they all terminate within 5 meters. The ceiling is present 27 meters inland, where it forms a 5-meter wide arch across the cave, before the ceiling is breached by a large collapse measuring 20 meters by 7 meters that connects to the surface, leaving less than 5 meters of ceiling width around the periphery of the large skylight entrance. Farther inland the ceiling remains intact for the remainder of the cave except for the most inland portions, which is breached and connects to the land surface. Minor speleothems are seen throughout the cave and one significant side passage is present in the southeast corner of the feature near the seaward entrance. This passage is located 3 meters above the floor on the cave wall and forms a looped passage over 10 meters long, averaging 2 meters in height and width. This significant feature not only represents one of the larger caves on Tinian, but it well represents an intermediate stage in the transition from flank margin caves to coves that are seen on Tinian. The coves located farther south at Unai Masalok and Unai Dangkolo have experienced greater erosion from coastal process, while more intact caves like Liyang Dangkolo show limited breaching primarily by ceiling collapse. Therefore, Hidden Beach Cave shows the transition stages in coastal erosion from complete flank margin caves to coves on carbonate islands.

Hollow Column Cave (Lower Terrace, Aguijan – Figure 90)

Hollow Column Cave is a remnant flank margin cave that has been intersected by cliff retreat on the southern side of Aguijan. It is developed in the Mariana Limestone (QTmu) and extends inland for 20 meters with an average width of 8 meters. In the inland portions of the cave some speleothems are present, including one column that is approximately 3 meters tall. The cave appears to be the side chamber of a larger flank margin cave that has been removed by cliff retreat. A narrow, dissolutionally widened joint trending approximately north is present in the ceiling and may represent structural control on the original dissolution of this chamber.

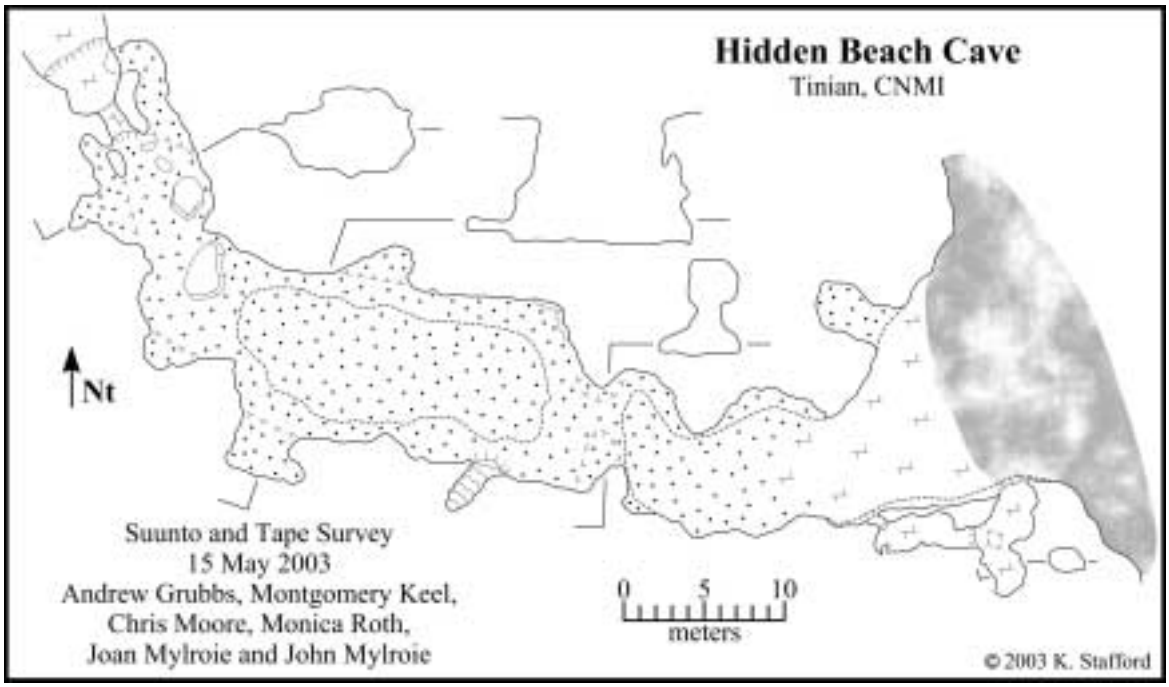

Figure 89: Map of Hidden Beach Cave.

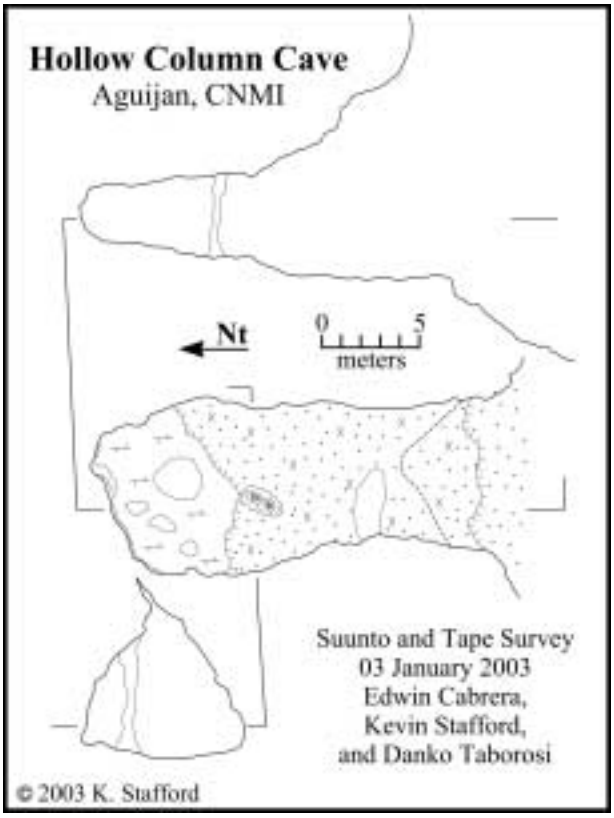

Figure 90: Map of Hollow Column Cave.

Insect Bat Cave (Middle Terrace, Aguijan – Figure 91)

Insect Bat Cave is located on the southwest side of the Middle Terrace in the Mariana Limestone (QTmu). It is developed along a fracture trending 120° and extends inland 30 meters with two distinct levels. The upper level is approximately 15 meters above the land surface and averages 3 meters in width, with a narrow slot in the floor that connects to the lower level, which has an average width of 2 meters. A small passage extends to the northeast for 5 meters from the lower level with an average width of 1.5 meters. The feature appears similar to sea-level fracture caves that discharge freshwater and is interpreted as representing a paleo-discharge feature that developed along a fracture.

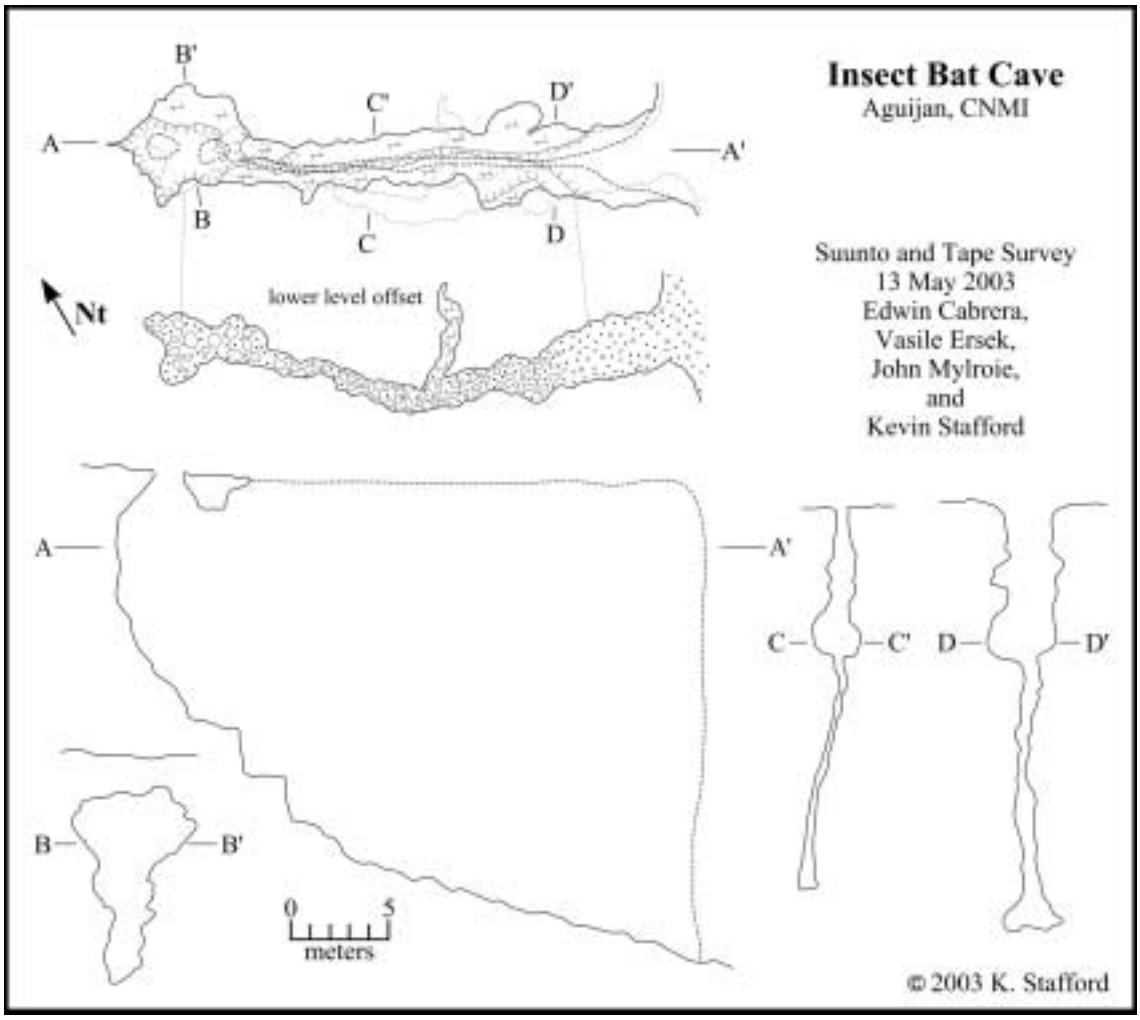

Figure 91: Map of Insect Bat Cave.

Isotope Cave (Upper Terrace, Aguijan – Figure 92)

Isotope Cave is a flank margin cave located in the northwest region of the Upper Terrace in the Mariana Limestone (QTmu). It covers an area of 15 by 23 meters, with two entrances and a large chamber. The two entrances located in the southern portion of the cave connect through 1-meter a tall passage that averages 3 meters wide with alluvium floors. At the junction of the two entrance passages, the cave is 5 meters wide and 2.5 meters tall and dips to the north, where

the cave continues and turns north through a 2 meter wide, 1.5 meter tall passage that connects to the main chamber. The main chamber is 10 by 15 meters with and average ceiling height of 3 meters and numerous large breakdown blocks covering the floor. In the southern portion of the main chamber, extensive deposits of flowstone cover the floor and walls, while stalactites cover the ceiling and several stalagmites line the southeast wall. The northern portion of the main chamber is approximately 2 meters tall, but appears much shallower because of the numerous large breakdown blocks that fill the area. In the far northeast part of the cave a small, 5-meter long, 1-meter tall passage in the breakdown can be reached by a short downclimb. The cave is named for several large (1.5 meter tall), "broomstick" stalagmites, which were located and appear ideal for U/Th isotope analysis for age dating.

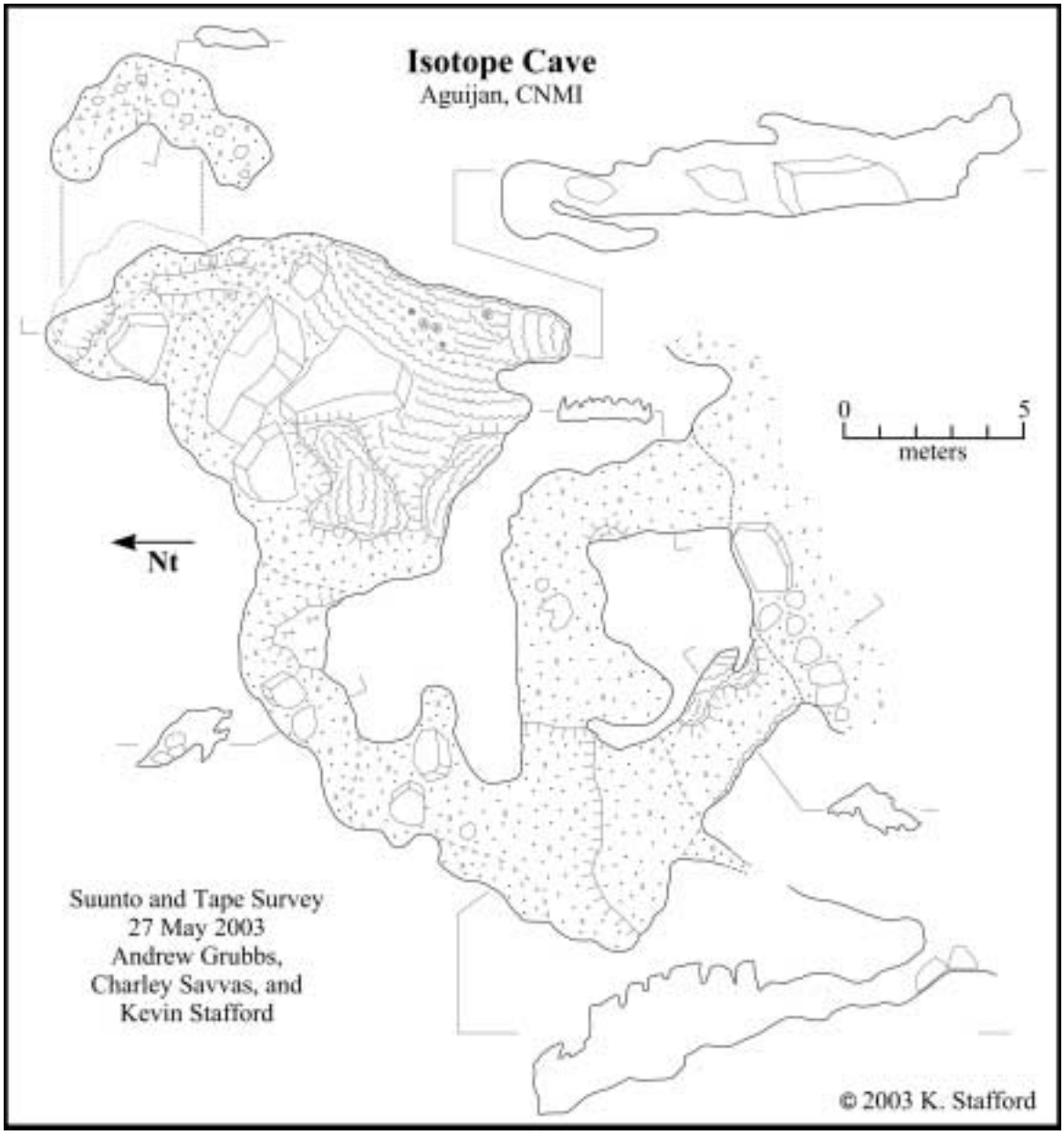

Figure 92: Map of Isotope Cave.

John's Small Cave (Median Valley, Tinian – Figure 93)

The entrance to John's Small Cave is located approximately 200 meters west of the Unai Dangkolo and is developed in the Mariana Limestone (QTmca). This FM cave is oriented roughly north by northeast with a length of 35 meters, width of 15 meters and depth of 12 meters. The entrance area is a complex collapse composed of numerous blocks and sediment. The southern portion of the cave exhibits less collapse, but has extensive speleothems and alluvium derived from sources to the south, in the direction of the small, unsurveyed passage at the far southern end of the cave. Throughout the cave, the original dissolutional morphology can be seen, but in most locations it is obscured by collapse or overprinted by speleothems. This cave and Liyang Dangkolo are approximately 20 meters apart in the subsurface, based on a surface survey that connects them.

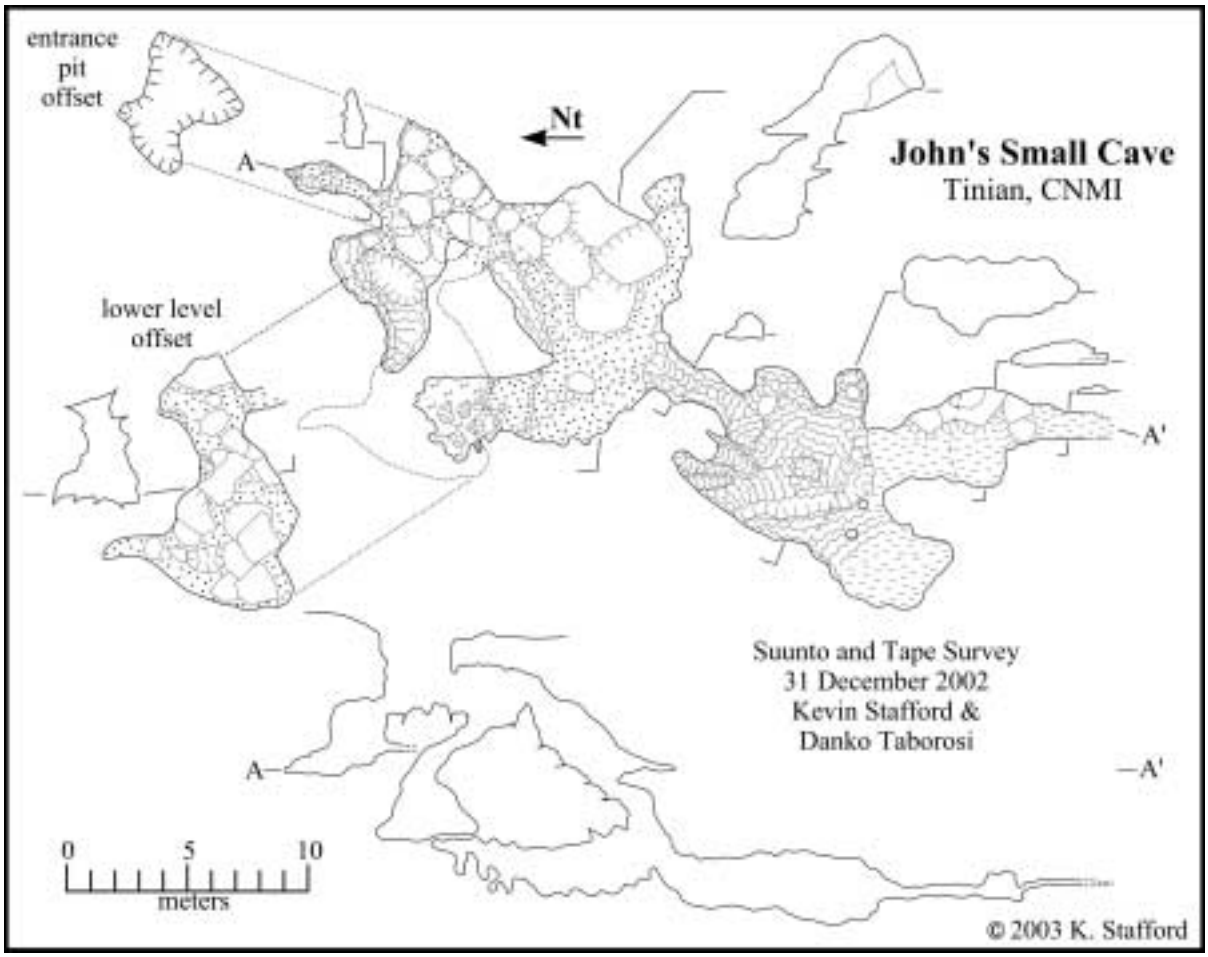

Figure 93: Map of John's Small Cave.

Lasu Recharge Cave (North-Central Highland – Figure 94)

Lasu Recharge Cave is located 1100 meters south of Mount Lasu on the eastern edge of a large closed depression, where allogenic waters from the igneous outcrops are sinking in the Tagpochau Limestone (Tt). This feature, located in a large bamboo grove, has much plant debris at its entrance indicating significant recharge during rain events. The central portion of the

feature is a collapsed entrance approximately 2.5 meters deep and oriented along a fracture trending southeast (~135°). The second entrance is located at the western edge of the feature where it meets the large closed depression and is where allogenic water primarily enters the feature. On the western side of the feature, there is another fracture trending southeast (~155°), which forms the far interior wall. Water follows this 20-centimeter, dissolutionally widened fracture to the northwest. Although this feature only measures 6 meters by 9 meters with a total depth of 3 meters, it is significant as a point source recharge feature for groundwater.

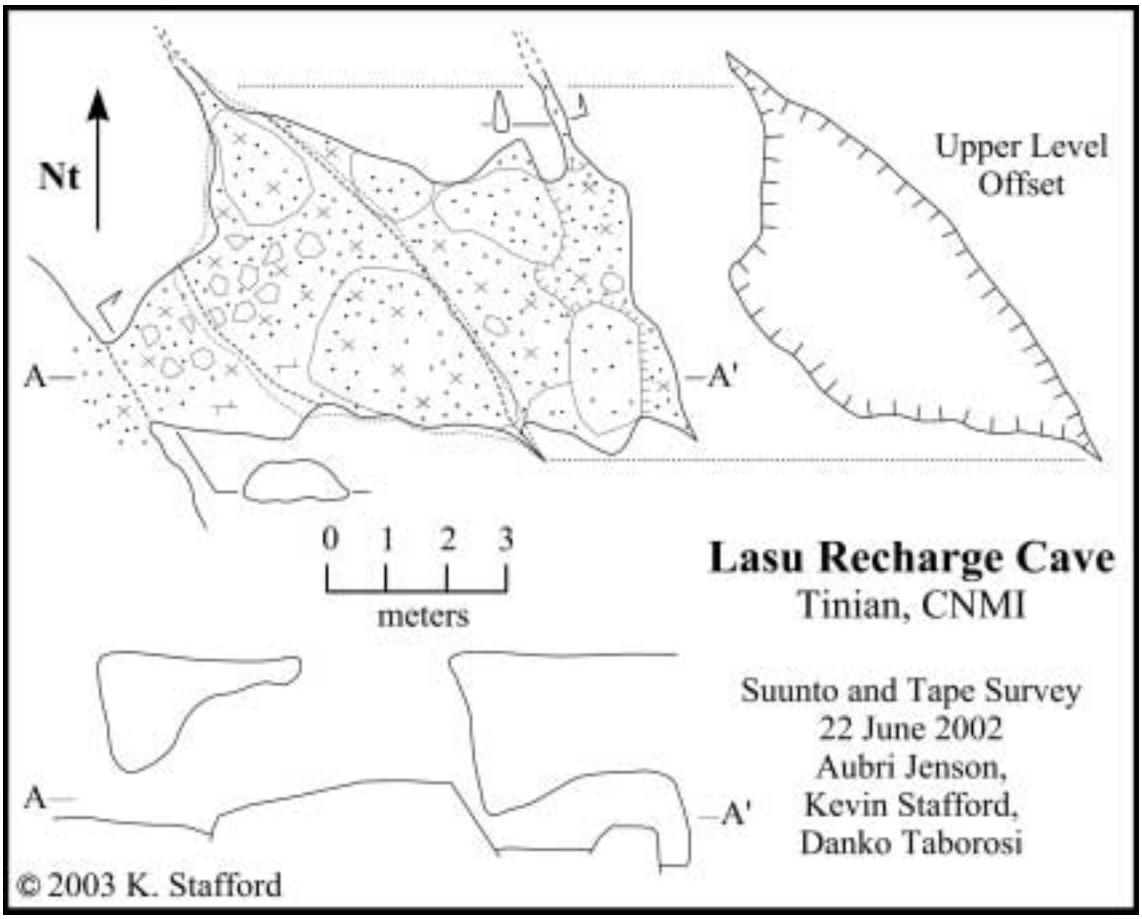

Figure 94: Map of Lasu Recharge Cave.

Leprosy Caves (Median Valley, Tinian – Figure 95)

The Leprosy Caves are breached, flank margin caves developed in dipping foreshore deposits in the Mariana Limestone (QTmu) on the coastline, approximately 200 meters south of the historic Leprosarium site. The site consists of series of three small caves and two large caves along a section of coast 120 meters long. The two large caves measure roughly 16 meters by 20 meters each with maximum ceiling heights of 8 meters. A ceiling breach on the inland side has created a second entrance to the southern large cave. The caves contain bedrock floors with some breakdown and carbonate sand near the entrances, but are devoid of speleothems. These caves all show evidence of being impacted by intense surf, which may explain the complete absence of speleothems.

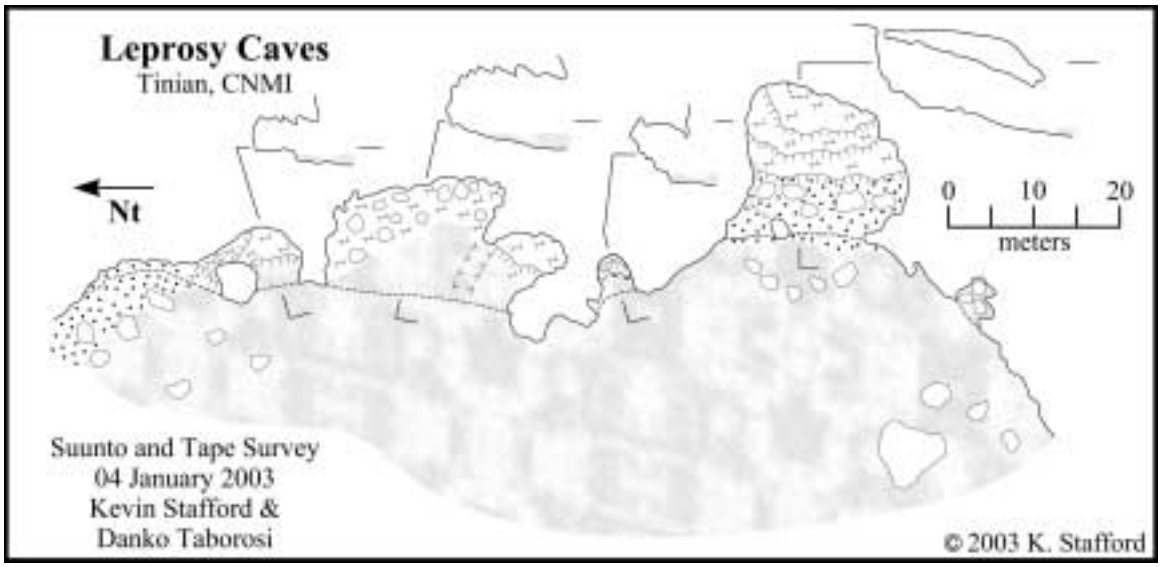

Figure 95: Map of Leprosy Caves.

Leprosy Discharge Feature (Median Valley, Tinian – Figure 96)

The Leprosy Discharge Feature is located near the "Historic Leprosarium Site" in the Mariana Limestone (QTmu). The feature is approximately 25 meters long, 7 meters wide and 2 meters deep. The feature has two small natural bridges located in the eastern portion where weathering of dipping foreshore deposits has eroded out beds preferentially. Along the walls of the feature that are in contact with ocean water, there are small-scale dissolutional features that appear to represent mixing dissolution from discharging freshwater. Minor mixing of fresh water was observed, but due to strong surf conditions, no significant salinity variations could be detected.

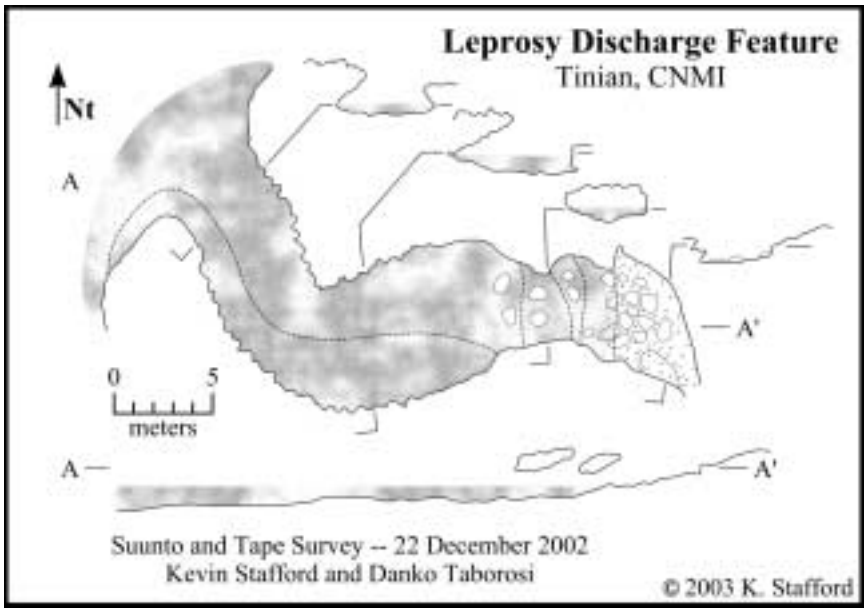

Figure 96: Map of Leprosy Discharge Feature.

Liyang Atkiya (Lower Terrace, Aguijan – Figure 97)

Liyang Atkiya is the largest cave yet discovered on Tinian or Aguijan, has a length of 200 meters and a width ranging from 25 meters in the 15-meter tall entrance chamber to 8 meters wide and 5 meters tall in the inland portions. The feature is developed in the Mariana Limestone (QTmu) along the southern side of the Lower Terrace on Aguijan. The entrance is developed along the base of a small cliff and measures approximately 7 meters wide and 1.5 meters tall. From the entrance the cave extends to the north into a large chamber with numerous large breakdown blocks, which form a steep slope over a distance of approximately 80 meters. At the base of the breakdown slope, in the main chamber, are several pools of freshwater and numerous speleothems. This region is also coated with a thin layer of black sediment, possible manganese, which not only coats the walls, but forms thick, black mud and causes a black coloration to the pools of water.

Continuing north, past a man-made rock wall, there is a small 1-meter diameter tube that extends for less than 2 meters into a small chamber containing more black sediment and speleothems. From this small chamber a long, linear passage extends for 75 meters, while continuing to slowly descend deeper. This passage trends northwest and appears to be developed along a fracture. However, large amounts of breakdown from the ceiling completely cover the floor adding complexity to the passage. In the northern portions of the cave, the main passage turns abruptly west and continues in the same fashion, while the original passage trend continues for 30 meters at a slightly higher level and smaller size. The west trending passage was surveyed for 50 meters at a near-level elevation, but two passages continue from this west passage that were not surveyed because of field logistics. However, the main trend continues for approximately 30 meters past the end of the survey as a 2-meter wide, 1-meter tall passage, while a second passage branched off to the south into a series of small, maze-like passages.

This cave represents a complex morphology that does not fit traditional models for carbonate island karst. The large entrance chamber is similar to a flank margin cave that has undergone extensive collapse, but has no side chambers as normally observed in flank margin caves. The long, linear passages appear to follow fractures and in several places retain scallops on the walls that indicate phreatic flow. These scallops are oriented towards the entrance, indicating that water would have flowed upwards through the cave towards the entrance, having originated in the most inland portions of the cave. Much of the interior area of the cave contains extensive breakdown, but low mazy areas may indicate the areas where water entering the explored portion of the cave merged into a single conduit.

Liyang Barangka (Southeastern Ridge, Tinian – Figure 98)

Liyang Barangka is a large, collapsed, flank margin cave located on the east coast, 600 meters north/northwest of Puntan Barangka in the Mariana Limestone (QTmu). The feature is 65 meters long, up to 50 meters wide and 15 meters deep. The majority of the feature does not retain a roof, but large breakdown blocks covering the bedrock floor throughout the feature appear to have once formed the roof. Ceiling remnants occur along the edges of the feature, extending less than 5 meters from the walls, while a single, small, covered chamber extends from the southwest corner of the feature for 6 meters. The eastern region of the feature extends below sea level and the entire feature shows evidence of impacts from intense storm events. The walls have flowstone deposits, while numerous large breakdown blocks in the central area have eroded speleothems on them. This feature is similar to the coves near Unai Dangkolo, but appears to be more severely impacted by coastal processes.

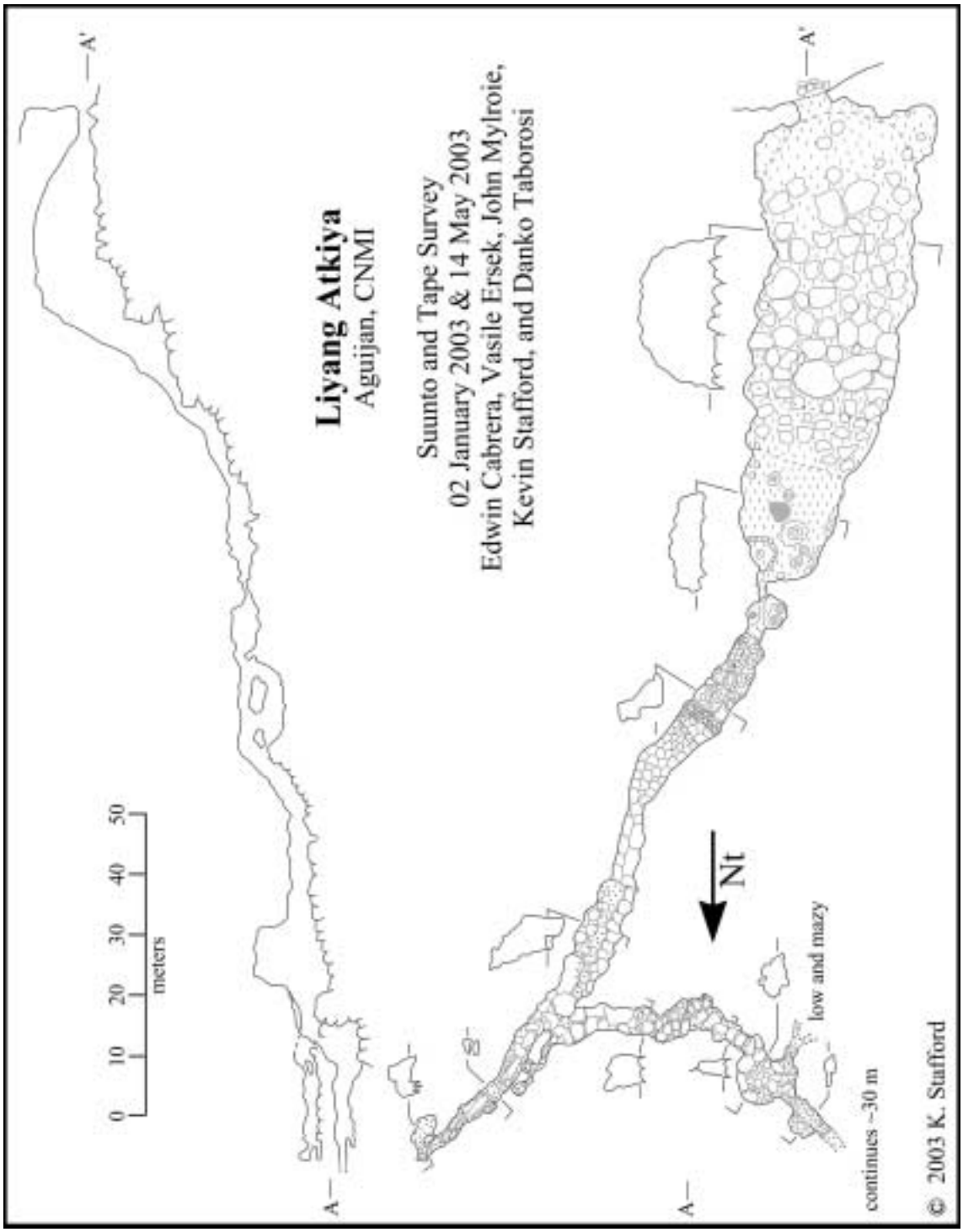

Figure 97: Map of Liyang Atkiya.

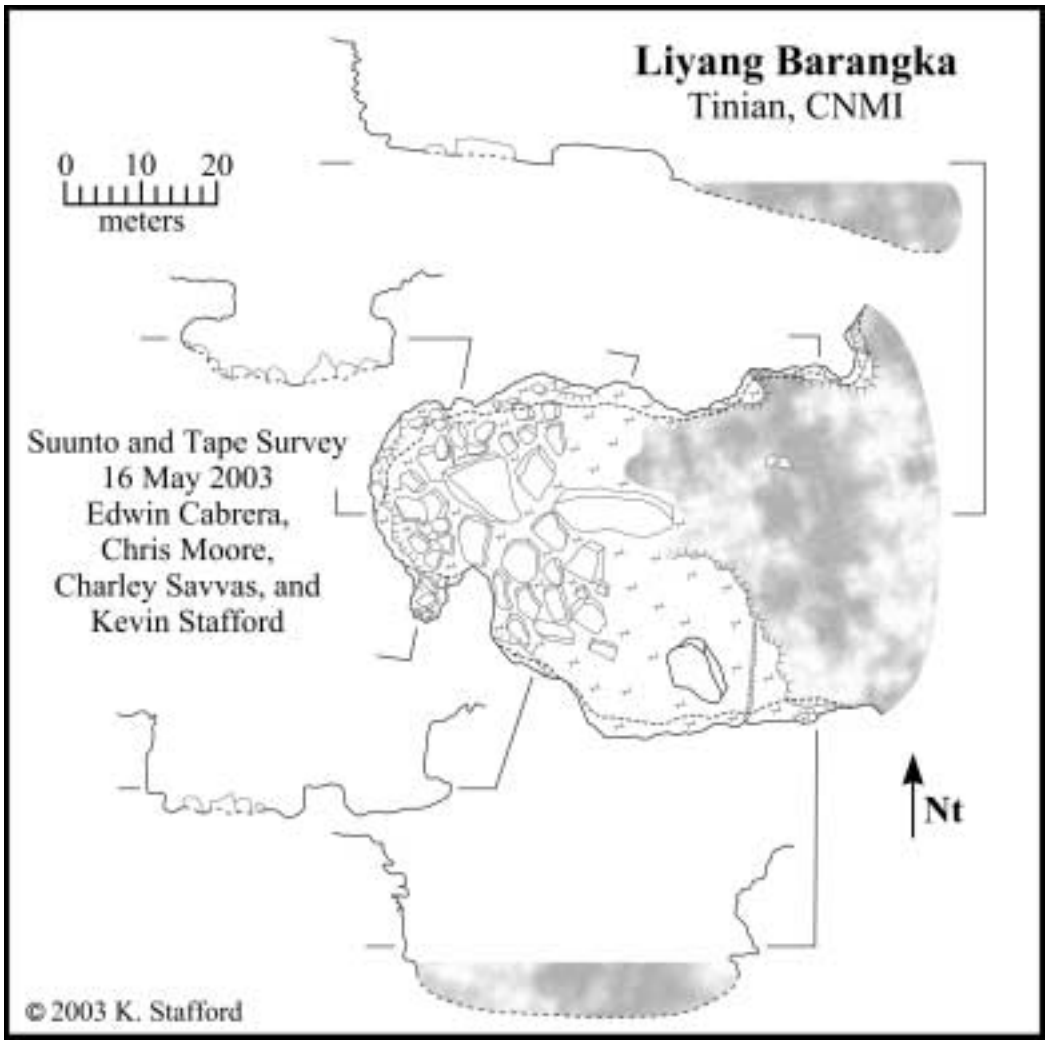

Figure 98: Map of Liyang Barangka.

Liyang Dangkolo (Median Valley, Tinian – Figure 99)

Liyang Dangkolo, also known as Long Beach Cave, the largest cave on Tinian, is approximately 100 meters inland from Long Beach (Unai Dangkolo). It is developed in the Mariana Limestone (QTmca) and measures approximately 35 meters by 70 meters with a central main chamber that extends to 16 meters depth. The cave contains several large bedrock pillars that separate areas and numerous smaller passages extending off of the main chamber in all directions. The cave appears to be predominantly intact with four entrances located in the ceiling of the main chamber, requiring a vertical descent to enter to the cave. In various areas of the cave, speleothems are extensive, while the main chamber floor is composed of breakdown talus created by the collapse of the ceiling. In the far eastern part of the cave, there is a large amount of carbonate sand, which may indicate a second breached entrance, possibly Andyland Cave. Through the center of the cave, a dissolutionally enhanced, north/south trending fracture is present that is associated with the largest collapse entrance. This large cave represents archetypical flank margin cave development for the Island of Tinian. Throughout the cave, minor human modifications have been made including the construction of a stacked rock wall in the east central area.

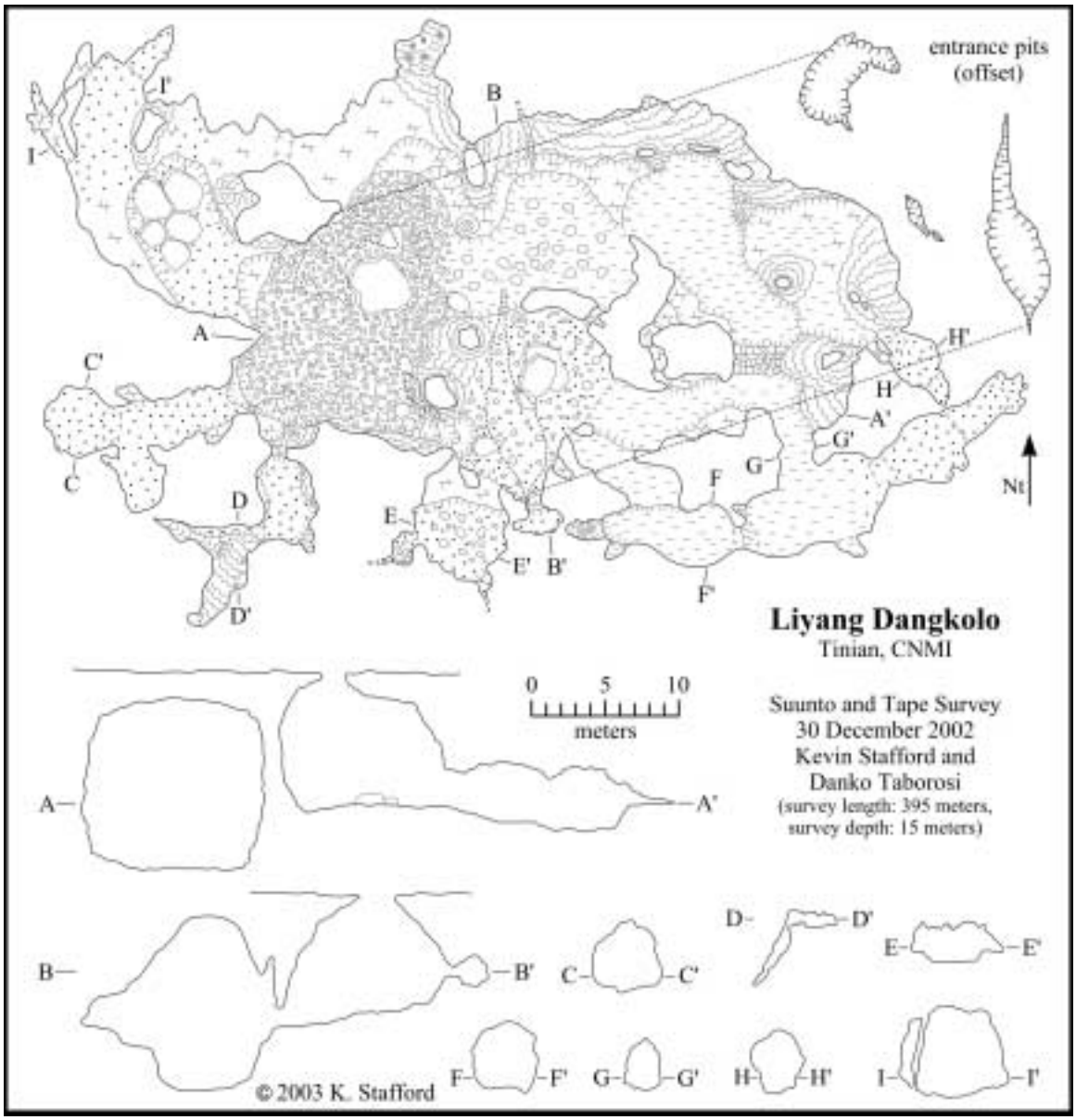

Figure 99: Map of Liyang Dangkolo.

Liyang Diapblo (Central Plateau, Tinian – Figure 100)

Liyang Diapblo is a large, breached, flank margin cave on the western coast, 300 meters southeast of Puntan Diapblo in the Mariana Limestone (QTmu). The entrance to the feature a small cove, 40 meters wide that extends inland 70 meters with a large bedrock mass (12 meters wide by 35 meters long) in the middle. The cave is divided into several areas. South of the large bedrock mass, the feature contains no roof and extends up to 4 meters below sea level. East of the bedrock mass is a small chamber that extends inland 8 meters with a height of 4 meters. Northeast of the bedrock mass is a large passage with a breakdown covered floor that extends 30 meters with and average width of 8 meters and average ceiling height of 6 meters. Northwest of the bedrock mass is a large chamber 15 meters wide, 20 meters deep and 8 meters tall that contains a large flowstone mound 4 meters tall in the center of the chamber and several smaller

flowstone deposits around the periphery of the chamber. Directly north of the bedrock mass is a series of smaller interconnected passages leading to the eastern and western parts of the cave. This cove appears to have formed by roof collapse of the flank margin cave that consisted of a large chamber with several smaller side chambers separated from main chamber by a large bedrock pillar.

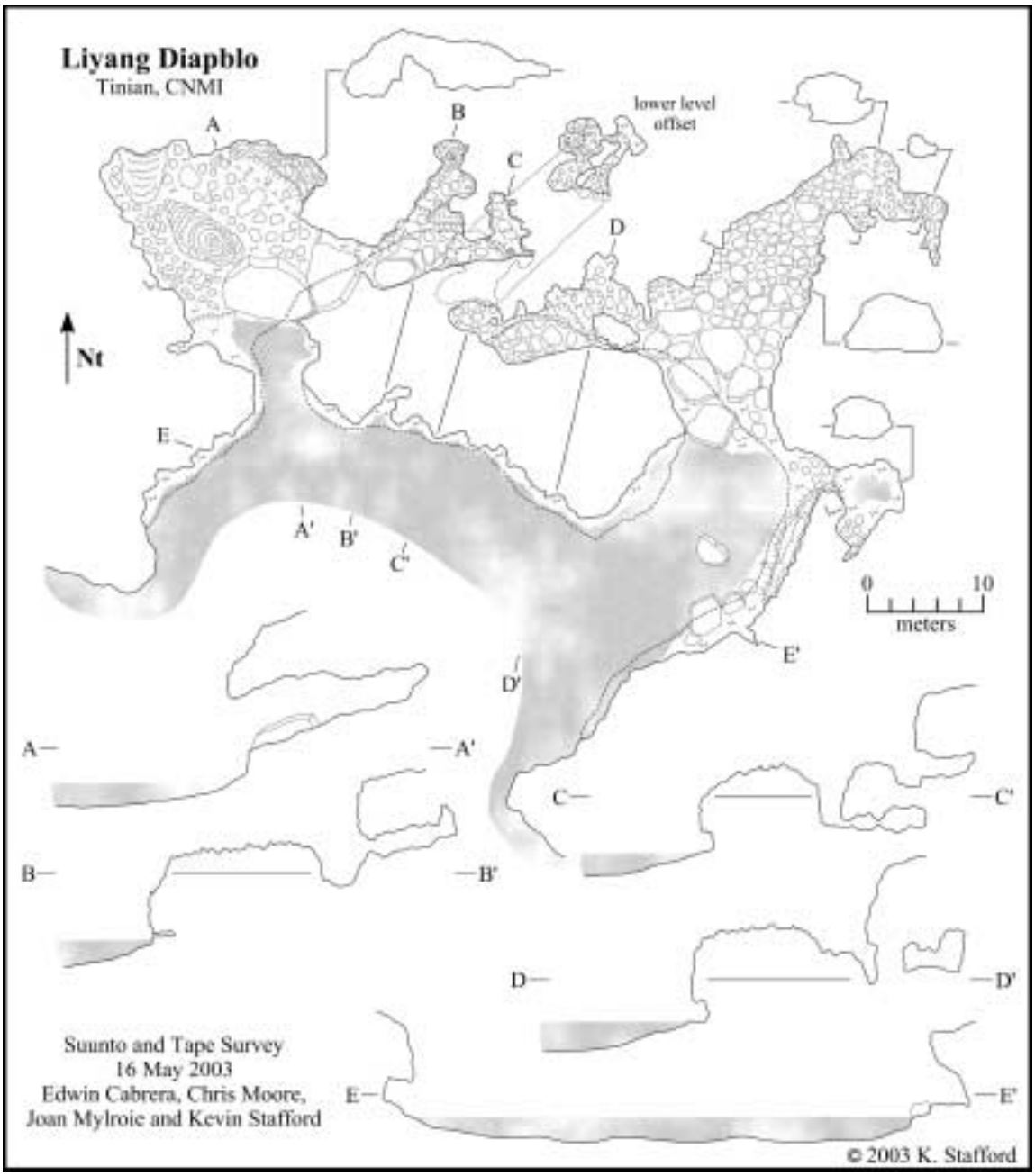

Figure 100: Map of Liyang Diapblo.

Liyang Gntot (North-Central Highland, Tinian – Figure 101)

Liyang Gntot is located on the northern scarp of Mount Lasu, approximately 3600 meters west of Unai Chiget in the Tagpochau Limestone (Tt). The cave consists of three distinct chambers that extend inland from a common entrance 16 meters wide. The individual chambers average 3 meters tall and 4 meters deep with floors composed of soil, detritus and scattered breakdown blocks. The feature shows evidence of minor human modification, primarily through leveling of soil floors and was not surveyed at the time of discovery because of time constraints while visiting the region.

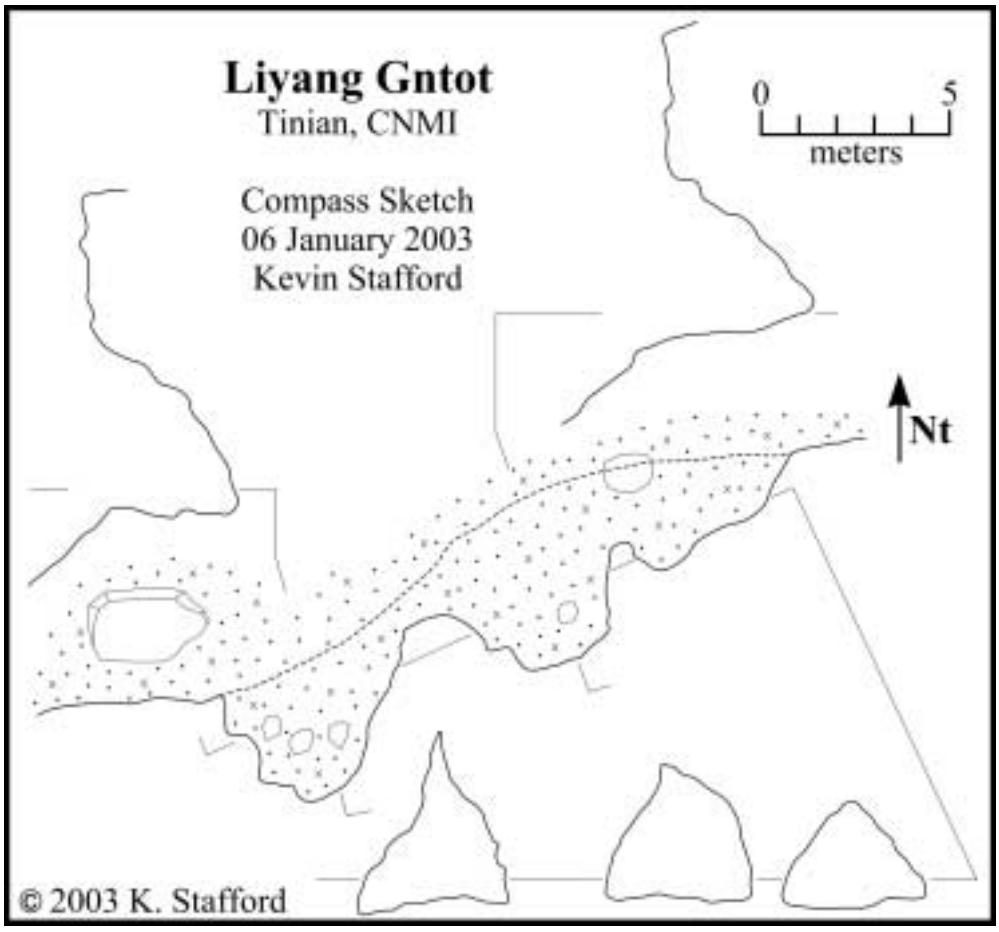

Figure 101: Map of Liyang Gntot.

Liyang Lomuk (Middle Terrace, Aguijan – Figure 102)

Liyang Lomuk is a breached, flank margin cave located in the north-central region of the Middle Terrace in the Mariana Limestone (QTmu). It consists of two flank margin cave remnants that extend west of the local scarp. The northern remnant is composed of a main chamber 5 meters wide, 6 meters deep and 3 meters tall, with two small, elevated passages extending from the southwest side of the main chamber. The main floor is composed of alluvium with the elevated areas composed of bedrock. The southern cave remnant is smaller and extends inland 5 meters. It is split vertically by a 0.5 to 1 meter thick bedrock shelf with the lower floor composed of alluvium and a small 0.5-meter deep depression in the east-central part. The cave is named after nearby trees referred to as “Lomuk” in the Chamorro language.

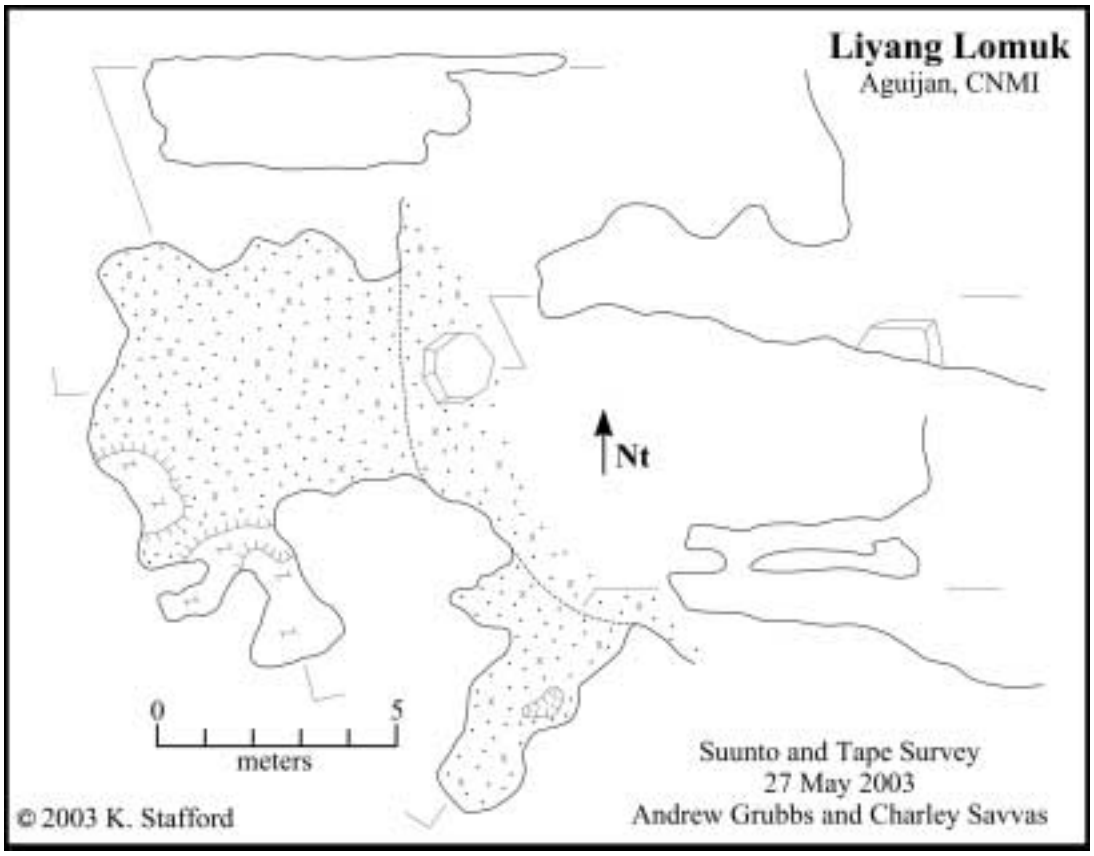

Figure 102: Map of Liyang Lomuk.

Liyang Mohlang (Southeastern Ridge, Tinian – Figure 103)

Liyang Mohlang is located in the north central part of Carolina's Ridge, in the Tagpochau Limestone (Tt). Two entrances are present in the northwestern portions of the cave, with the larger one containing a concrete staircase. The feature is 20 meters deep, 25 meters wide and 34 meters long, consisting of a chamber with by a large bedrock pillar. Speleothems are extensive in the eastern part of the cave, while the part is dominated by breakdown. The overall morphology of the cave appears to be that of flank margin cave; however, the large accumulation of breakdown, with a ceiling that shows little evidence of collapse, complicates this interpretation.

Liyang Popporput (Southeastern Ridge, Tinian – Figure 104)

Liyang Popporput is a fracture cave located approximately 1000 meters southwest of Puntan Barangka, along the northeastern cliffs of Carolina's Ridge. It is developed in the Mariana Limestone (QTmca) as a steeply dipping, dissolutionally enhanced fracture that is oriented northwest at a bearing of 80^{o}. This fracture cave is 40 meters long, 23 meters deep and has a maximum width of 2 meters. The feature is located in a region with numerous smaller fractures that cannot be explored as extensively. In the western part of the feature, where there is a partial roof of collapse material, some minor speleothems coat the walls.

Cliff retreat in this region has created a complicated assemblage of fracture caves that are acting as fast flow routes transferring water to the subsurface. It is expected that some of the features in this area extend to greater depths, but are either too small to explore, are blocked by breakdown as in this feature, or have not yet been discovered.

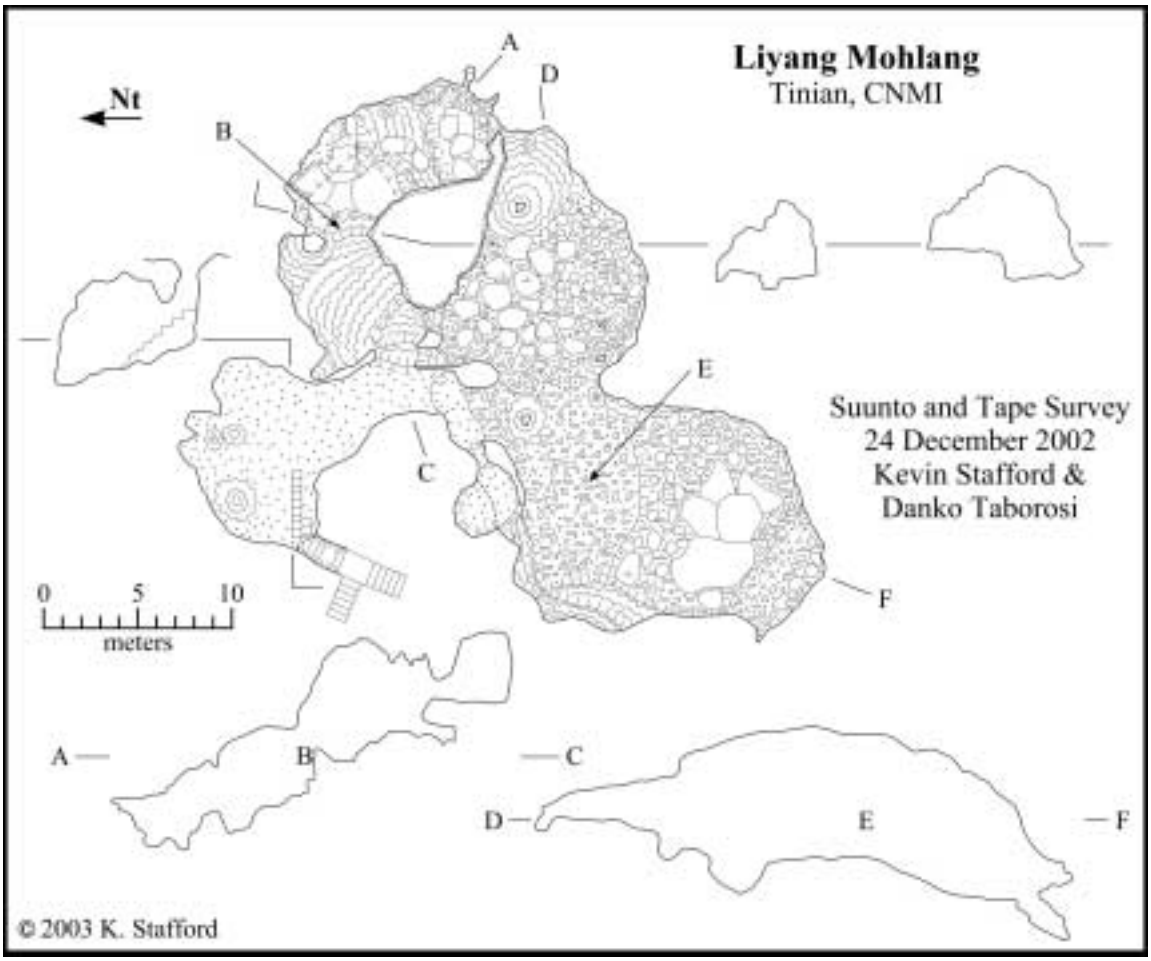

Figure 103: Map of Liyang Mohlang.

Liyang Sampapa (Central Plateau, Tinian – Figure 105)

Liyang Sampapa is located 250 meters south of Puntan Lamanibot Sampapa on the west coast. It is developed in the Mariana Limestone (QTmca) and extends inland 20 meters with a width of 8 meters and a bedrock floor. The entrance area of the cave is below sea level. The feature appears to be developed along an east/west trending joint trending that is well defined on the land surface, but less defined inside the cave. The feature appears to discharge minor amounts of fresh-water, but a definitive observation of discharge could not made at the time of survey because of strong surf conditions.

Liyang Umumu (Central Plateau, Tinian – Figure 106)

Liyang Umumu is located 900 meters north/northeast of Puntan Diapblo in the Mariana Limestone (QTmu), less than 3 meters below the land surface. It is a banana hole type cave with an average height of 1 meter, depth of 3.5 meters and entrance width of 11 meters. This small feature contains extensive speleothems including flowstone covering all walls and the floor in the northeast portion of the cave, several columns, and numerous stalactites covering the majority of the ceiling. The floor is primarily composed of soil and detritus with some scattered breakdown blocks.

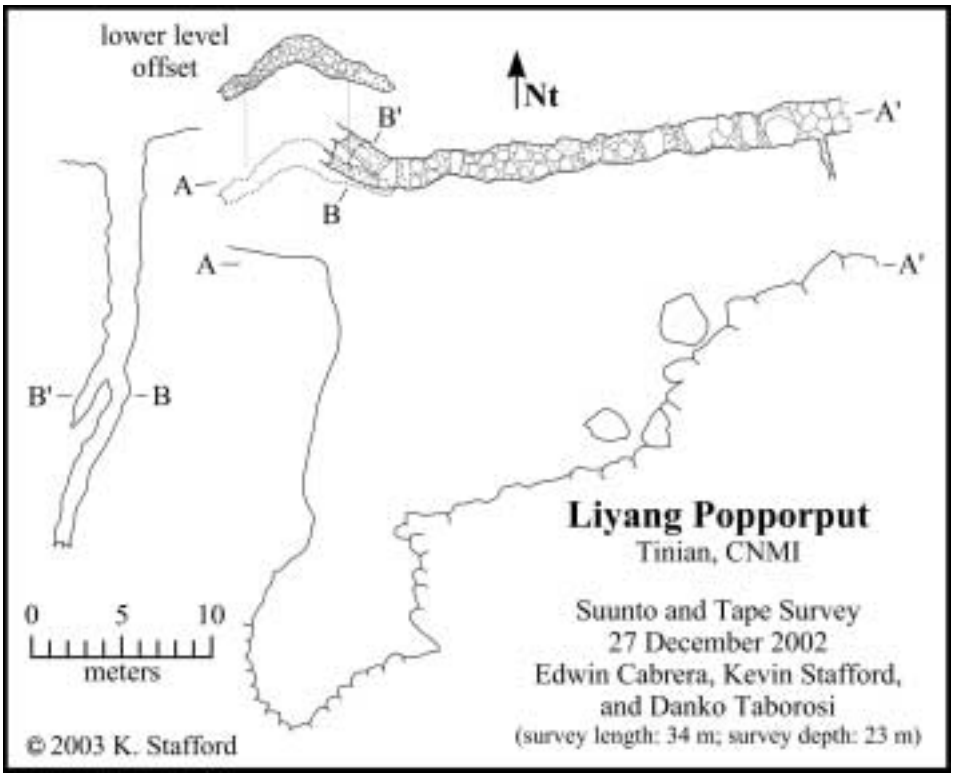

Figure 104: Map of Liyang Popporput.

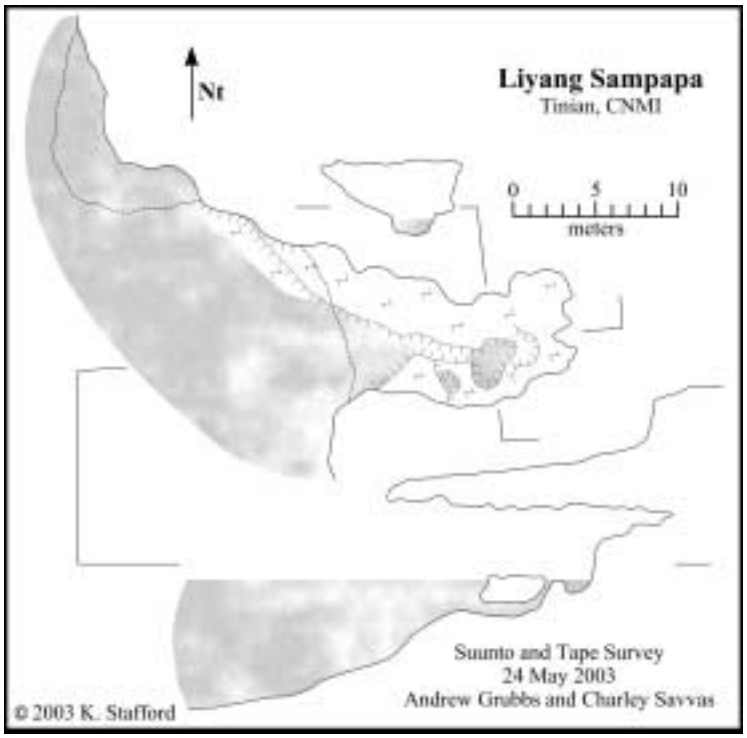

Figure 105: Map of Liyang Sampapa.

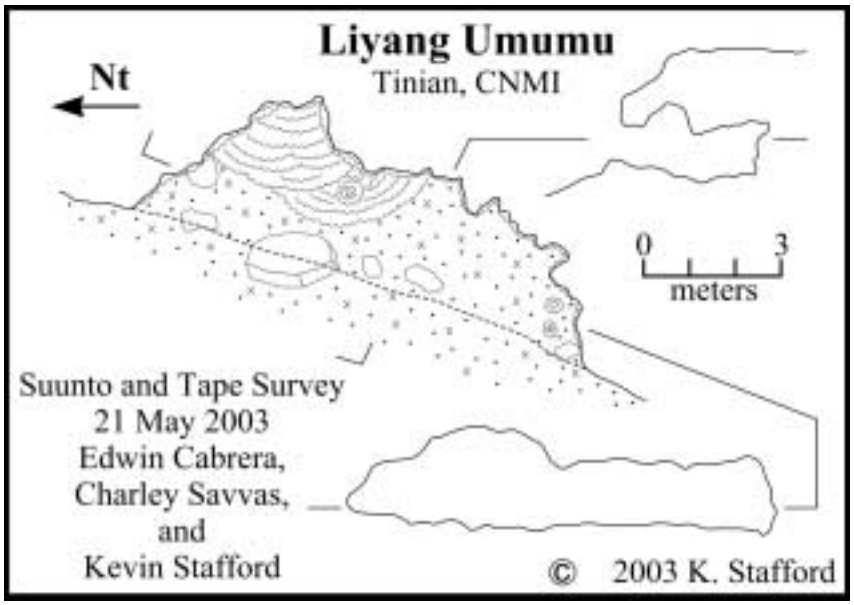

Figure 106: Map of Liyang Umumu.

Lizard Cave (Middle Terrace, Aguijan – Figure 107)

Lizard Cave is a small flank margin cave located on the north-central side of the Middle Terrace in the Mariana Limestone (QTmu). The cave extends inland 7 meters as two passages that average 3 meters wide and less the 2 meters tall. The floor is composed of alluvium and breakdown. One small passage continues from the inland portion of the southwest passage. The entrance area and northwest passage show evidence of extensive use by local fauna, primarily feral goats.

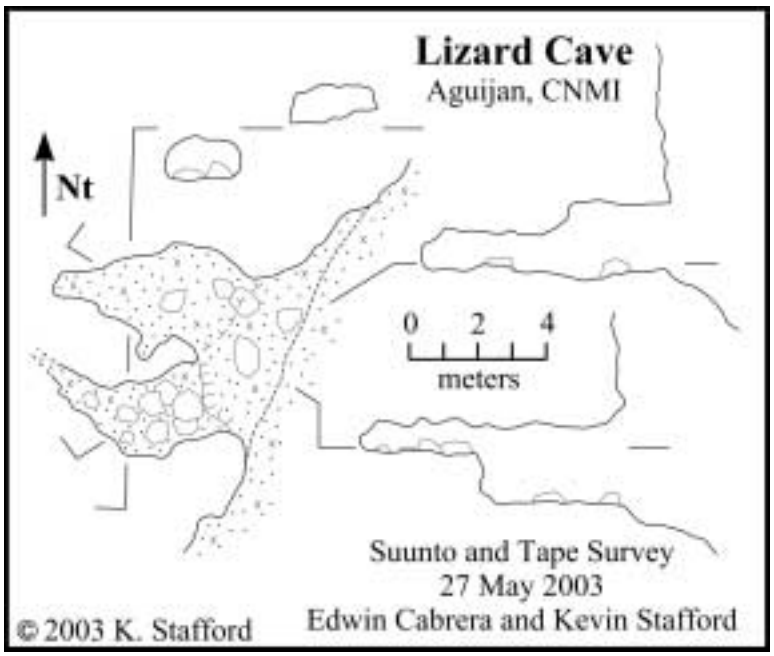

Figure 107: Map of Lizard Cave.

Lower Suicide Cliff Cave Complex (Southeastern Ridge, Tinian – Figure 108)

Lower Suicide Cliff Cave Complex is located near sea level, 2100 meters southwest of Puntan Kastiyu in the Mariana Formation (QTmu). It consists of a series of breached flank margin caves along a 190-meter. The cave complex is separated from the ocean by a series of algal-rimmed pools and extends inland up to 50 meters from the coast. The northern cave extends inland 25 meters with an average width of 10 meters. South of the northern cave is a long natural arch that retains an outer wall that is less than 3 meters, forming a 7-meter wide, 10-meter tall, and 50-meter long passage. South of the natural arch passage, three remnant cave chambers extend inland with development that trends inland and up the seaward dipping beds. The southern end of this cave complex is bounded by several large breakdown blocks produced from regional cliff retreat. This complex of caves provides and excellent example of lithologic control on the development of flank margin caves.

Masalok Fracture Cave Complex (Southeastern Ridge, Tinian – Figure 109)

The Masalok Fracture Cave Complex is located approximately 300 meters west/northwest of Puntan Masalok in the Mariana Limestone (QTmu), along the same fracture as the "600 Meter" Fracture System. This fracture strikes northwest and dips approximately 80^{o} to the northeast. At 42 meters, this feature is the deepest karst feature currently known on the island of Tinian. The main portion of the cave can be reached by a series of climb-downs, but the lower levels require the use of ropes and vertical equipment for safe exploration. Speleothems are common throughout the entire feature, especially in the form of flowstone coating the passage walls. The ceiling is composed primarily of large breakdown blocks, while the floor consists of breakdown and alluvium. Exploration in the main cave, which extends farthest to the northwest, was halted in both the northwest and southeast portions by breakdown. However, exploration in the eastern part of the feature led to the deepest parts of the cave, which includes a 40 meter near-vertical descent from the eastern most entrance. Based on survey data, the main, western part, of the cave and the eastern part of the cave are separated by less than 2 meters of breakdown blocks, confirming that they are effectively one cave. There is ponded fresh-water and a thick layer of mud at the maximum depth, in the eastern part of the cave, indicating that this area of the cave floods during recharge events. This feature demonstrates the importance of fractures as fast flow routes in eogenetic karst.

Mendiola Arch Cave Complex (Central Plateau, Tinian – Figure 110)

Mendiola Arch Cave Complex is located 1200 meters southeast of Puntan Atgidon on the southern edge of a large cove referred to locally as Mendiola Cove after the name of the landowner. It is a series of breached, flank margin caves developed in the Mariana Limestone (QTmu). The complex is split into two areas by a cave remnant that forms a natural arch that is 6 meters wide and 10 meters tall. Northeast of the arch is a series of four cave chambers which range from 5 to 15 meters wide and extend inland up to 20 meters with and average ceiling height of 5 meters. South of the natural arch, two larger caves have entrance widths of 18 and 24 meters and extend inland up to 25 meters. The caves in this complex primarily contain bedrock floors with breakdown blocks and cobbles. Based on the proximity of the features, it appears that some, if not all of the features were connected in the past and have been isolated as individual cave remnants by erosional, coastal processes.

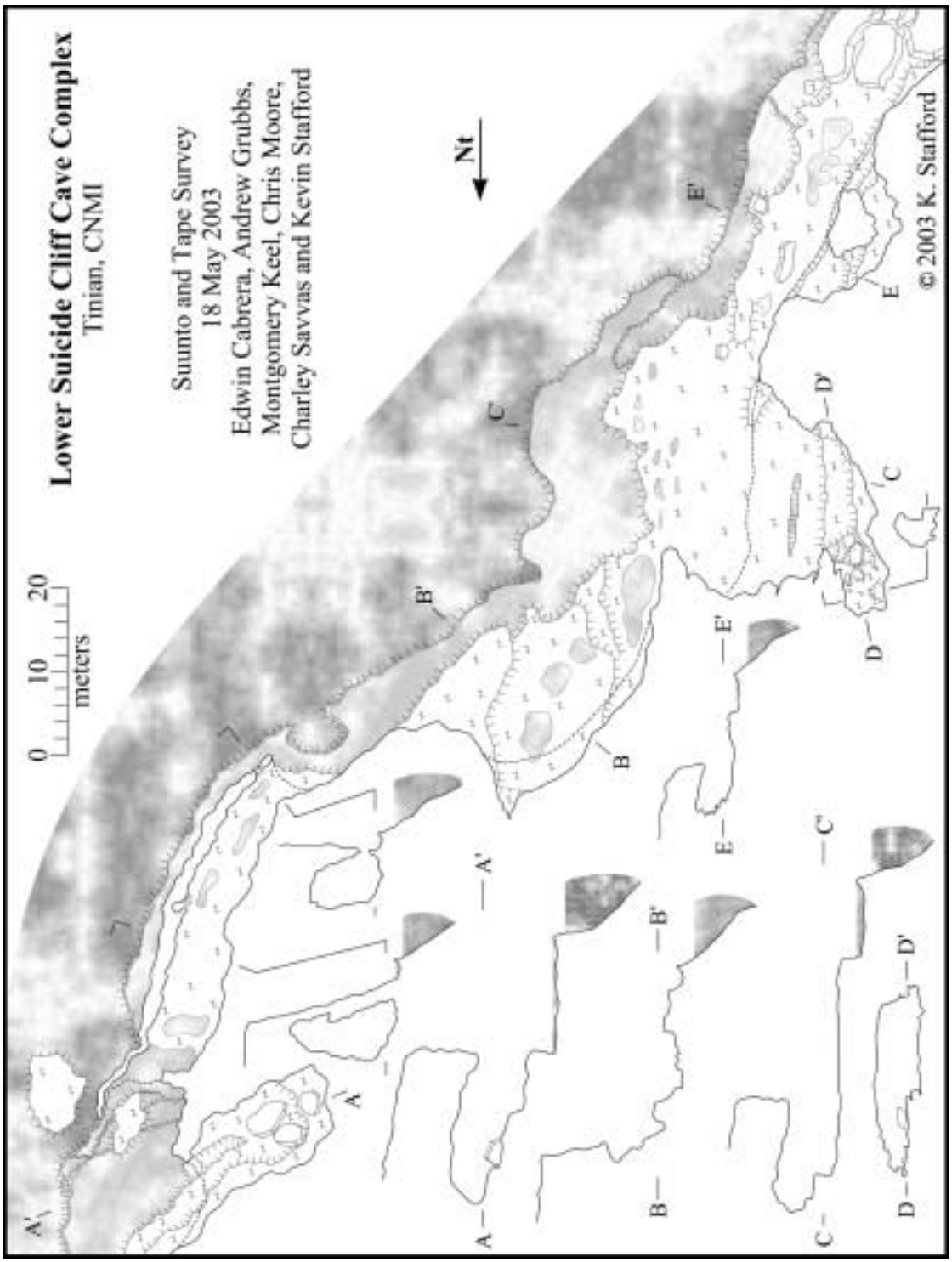

Figure 108: Map of Lower Suicide Cliff Cave Complex.

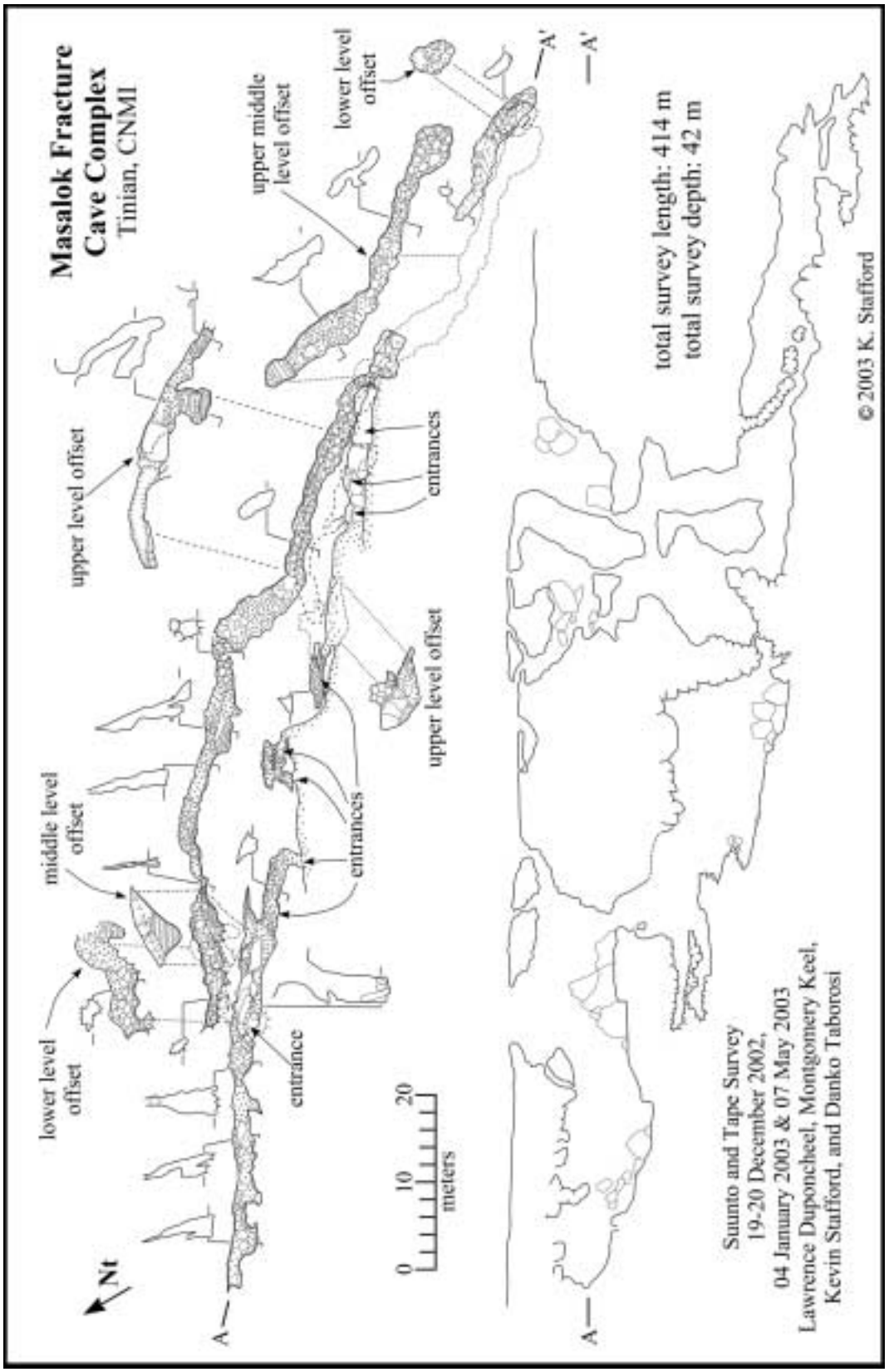

Figure 109: Map of Masalok Fracture Cave Complex.

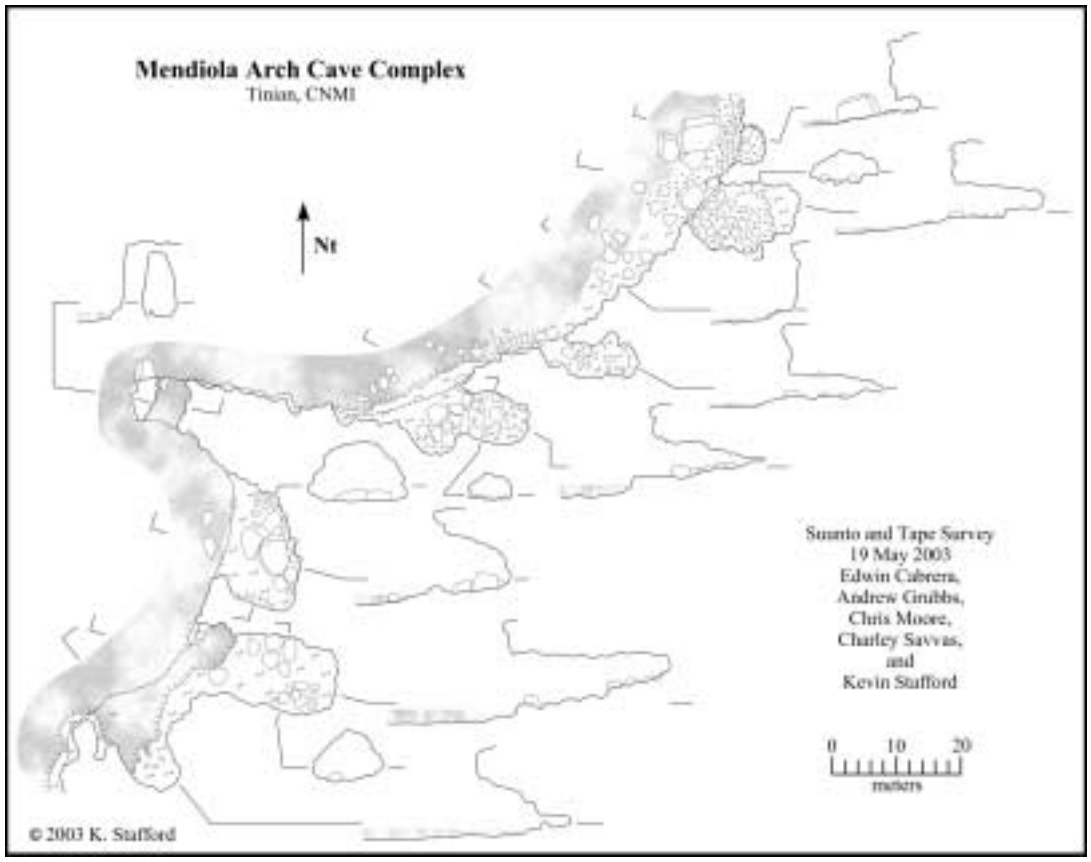

Figure 110: Map of Mendiola Arch Cave Complex.

Metal Door Cave (North-Central Highland, Tinian – Figure 111)

Metal Door Cave is a remnant, flank margin cave located 600 meters east of 8th Avenue on the northern scarp of Mount Lasu in the Tagpochau Limestone (Tt). It has an entrance area 10 meters wide that is divided by a 2-meter long bedrock column on the south side. The cave extends inland 15 meters with an average ceiling height of 3 meters and several small terrace levels in the inland part. The floor is primarily composed of soil and small rock fragments and has been extensively modified by humans. A 5-meter long, 2-meter tall rock wall conceals the majority of main entrance, while the main portion of the chamber has a leveled floor. The name of the cave is derived from a large metal door that was found 30 meters from the entrance.

Metal Spike Cave Complex (Median Valley, Tinian – Figure 112)

The Metal Spike Cave Complex is located approximately 500 meters inland from Unai Dangkolo, oriented northeast, approximately 10 meters west of the road to the same region. This feature consists of a series of collapsed flank margin caves in the Mariana Limestone (QTmca) with a few remaining chambers. It appears that the entire feature was connected in the past, but due to cliff retreat and collapse it is now disjointed. When connected, this feature would have been more than 130 meters long.

The southwestern part contains the largest collapsed chamber, which is approximately 12 meters in diameter and 2 meters deep, indicating that a large void collapsed at depth to create this surface expression. To the south of this collapse feature is a small roofed chamber approximately 5 meters by 6 meters with a 2-meter tall ceiling. To the west of the large collapse feature is a

large section of remnant flank margin cave that is developed along and partially under the western edge of the collapse. This chamber extends to a depth of 8 meters and contains speleothems throughout, including large columns in the entrance area.

Northeast of the large collapse feature is a 30 meter section of 5 meter high cliff wall, that has several small solutional chambers with speleothems located in and around them. This appears to be the remnants of the inland wall of flank margin cave development that has been almost completely removed by cliff retreat.

Continuing northeast across a 15-meter section of large angular limestone blocks, a second collapsed feature is present. This feature is approximately 5 meters by 10 meters with parts of the original roof remaining. Extending off the northeast corner of this second collapse feature is a small passage extends for an additional 8 meters, which contains speleothems and additional breakdown.

In the northeastern part of the cave complex is a series of partially breached chambers that extend are connected for approximately 40 meters with widths ranging from 4 to 8 meters and a maximum ceiling height of 5 meters. The southwestern portion of this region is a ceiling collapse entrance approximately 5 meters by 10 meters, with roofed chambers extending to the east and south. The far northeastern part consists of a 25-meter long passage that terminates in a 4 meter by 6-meter chamber with speleothems. This chamber is under the road to Unai Dangkolo. In the middle part of this passage, a pit entrance, which is approximately 1.5 meters in diameter, breaches the surface.

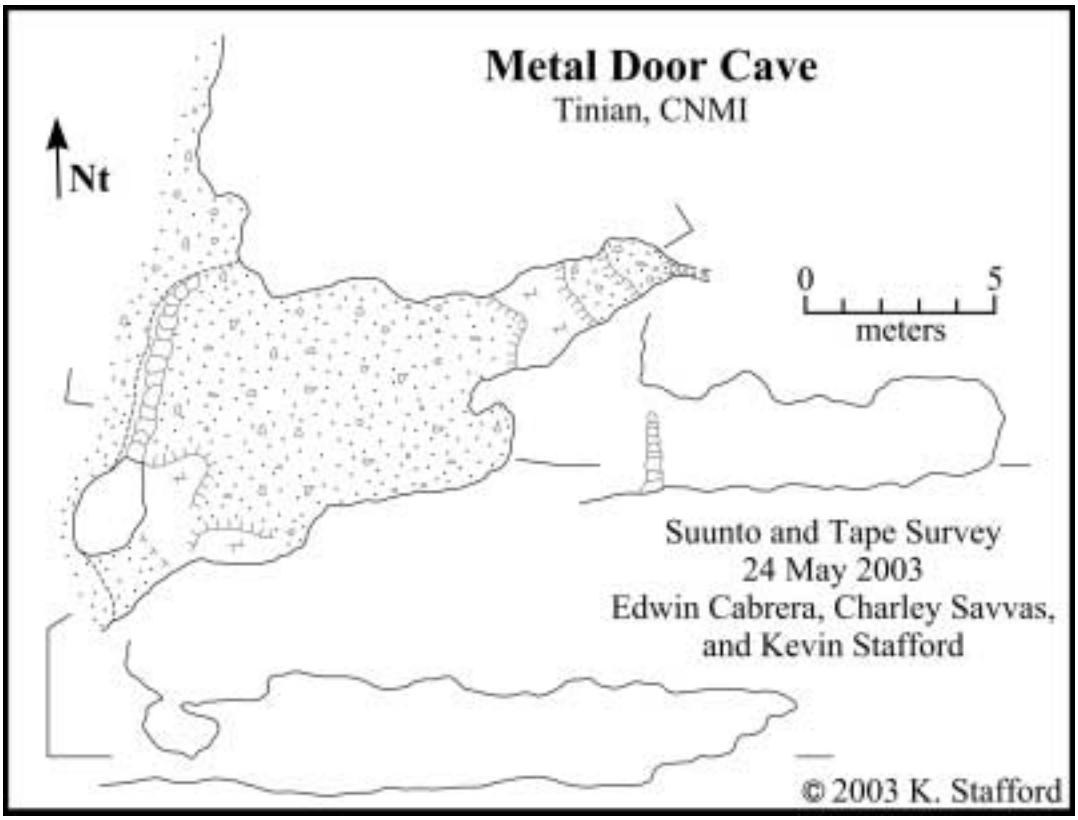

Figure 111: Map of Metal Door Cave.

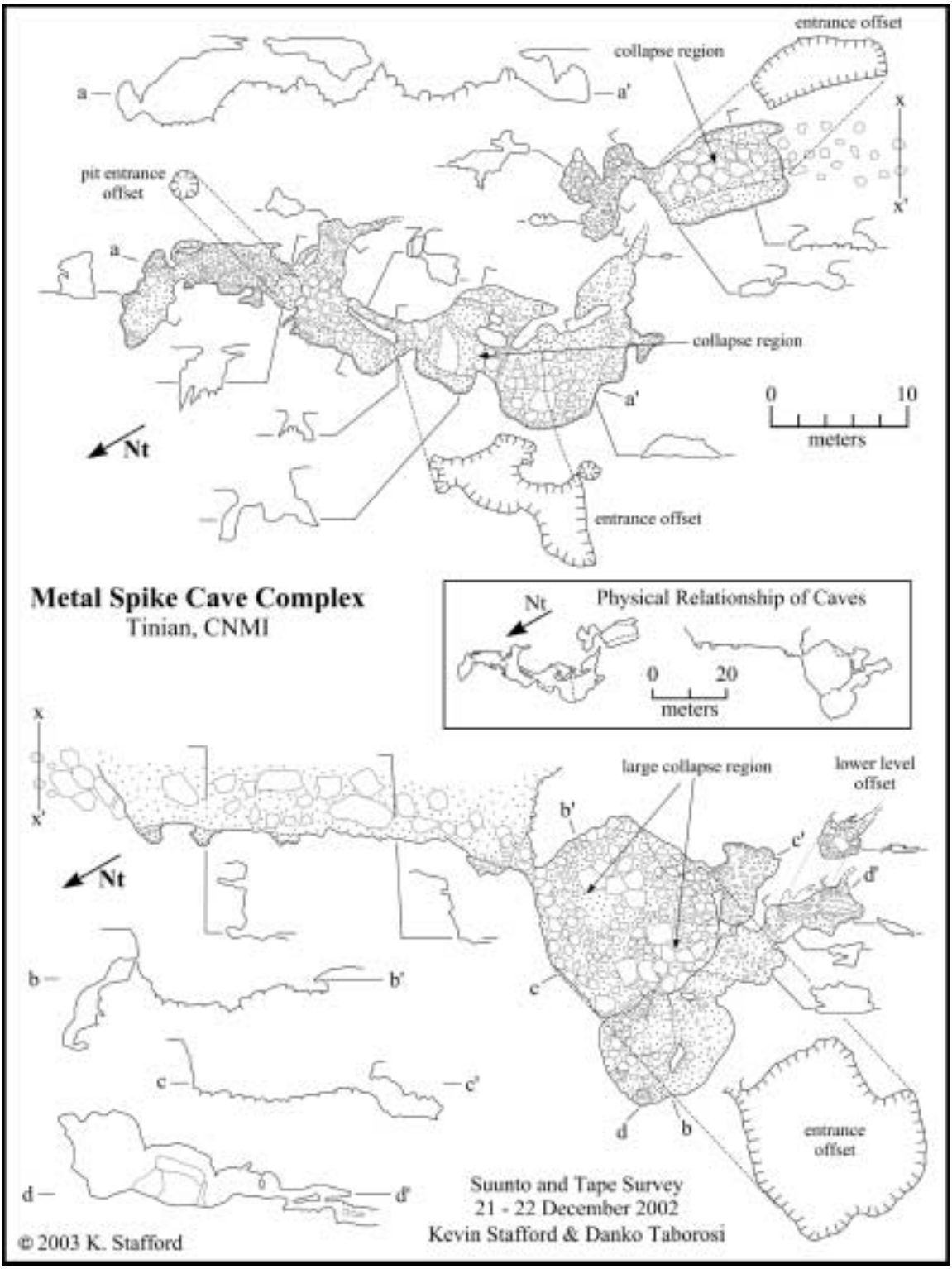

Figure 112: Map of Metal Spike Cave Complex.

Metal Stretcher Cave (Southeastern Ridge, Tinian – Figure 113)

Metal Stretcher Cave is located in the central portion of Suicide Cliffs, 25 meters above the base of the cliff. This feature is developed in the Tagpochau Limestone (Tt) and represents a remnant flank margin cave exposed by cliff retreat. It measures 12 meters wide at the entrance and extends inland 8 meters with a ceiling height of 6 meters. The feature contains speleothems, including two large columns in the entrance area. The cave appears to have had minor human modification in the entrance floor area, but is primarily in its original condition with only minor alluvium covering the floor.

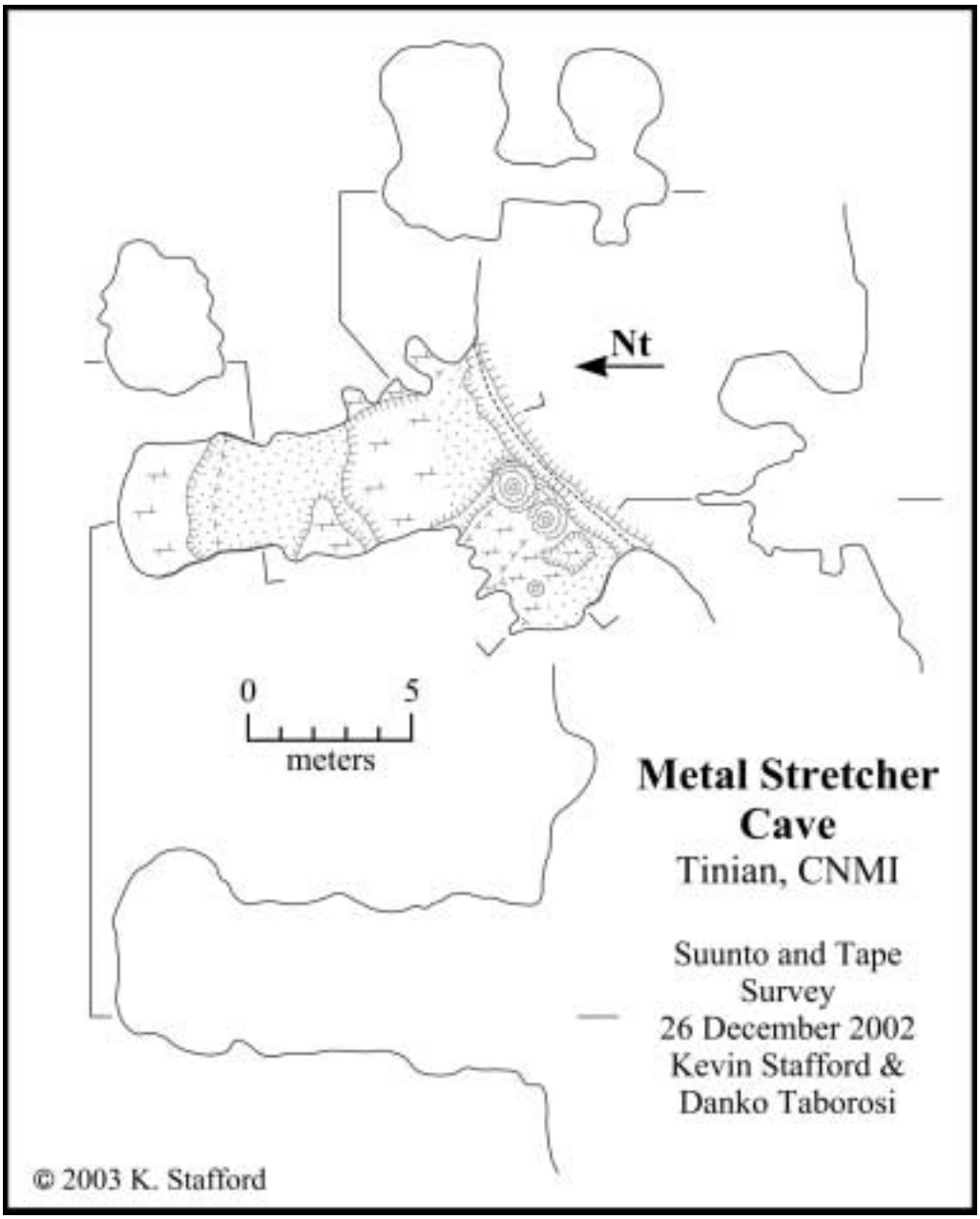

Figure 113: Map of Metal Stretcher Cave.

Modified Cave (Southeastern Ridge, Tinian – Figure 114)

Modified Cave is located in the central portion of Suicide Cliffs, at the base of the cliff, in the Tagpochau Limestone (Tt). The feature is a flank margin cave, which has extensive human modification to the entrance chamber, but little modification other than floor morphology in the larger, northern chamber. The feature is 9 meters by 4 meters with a maximum ceiling height of 3 meters. The larger chamber is a typical small, flank margin chamber with some ceiling collapse. This feature, although modified in the entrance area, represents a second horizon of dissolutional development along Suicide Cliffs, with the other prominent horizon located approximately 20 meters higher.

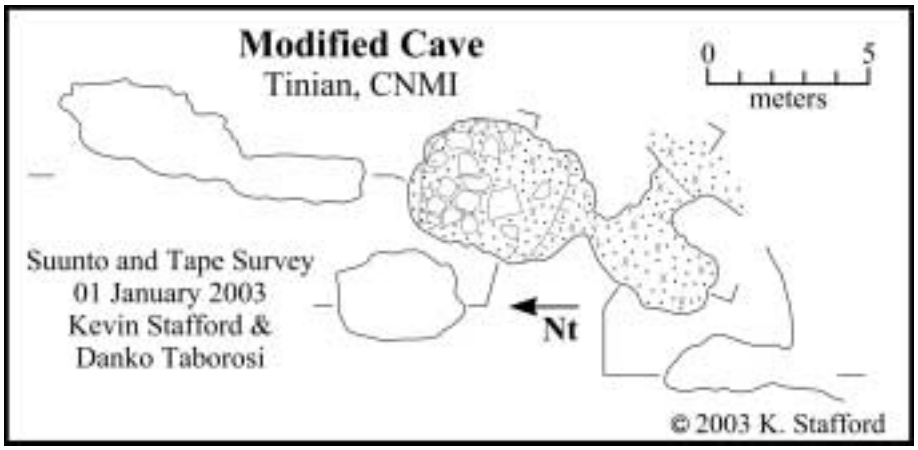

Figure 114: Map of Modified Cave.

Monica Wants to be Like Kevin Cave (Southeastern Ridge, Tinian – Figure 115)

Monica Wants to be Like Kevin Cave is located 800 meters east of Puntan Diapblo in the Mariana Limestone (QTmu). This flank margin cave remnant has an entrance 11 meters wide and extends inland 12 meters where it widens to 14 meters. The ceiling height averages 5.5 meters but decreases inland. The floor is composed of soil and detritus with a moderate amount of breakdown blocks in the middle of the cave.

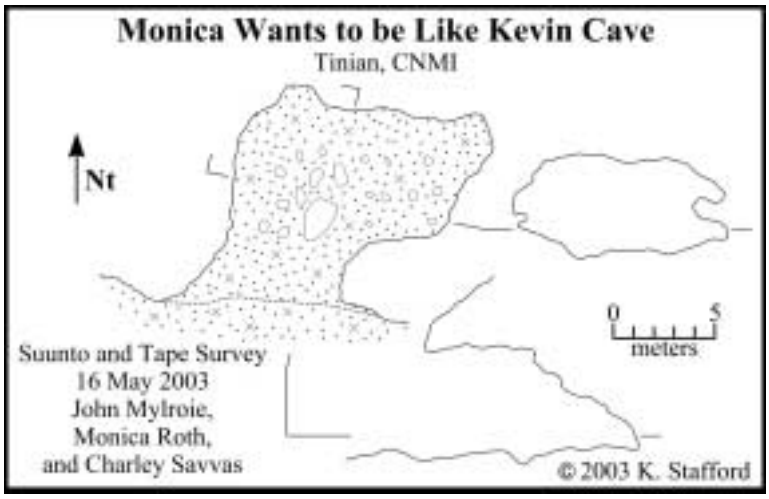

Figure 115: Map of Monica Wants to be Like Kevin Cave.

Natural Arch Cave (Middle Terrace, Aguijan – Figure 116)

Natural Arch Cave is a flank margin cave, developed in Mariana Limestone (QTmu), approximately 5 meters high on the scarp face in the southwest region of the Middle Terrace. It consists of a large entrance that is 18 meters wide and 8 meters tall with two passages extending to the north. The northeast passage extends inland for 4 meters, while the northwest passage extends inland 8 meters before intersecting a fracture-controlled passage 12 meters long that is oriented at 35°. The floor is composed primarily of alluvium in the entrance area with elevated levels containing bedrock floors. The fracture-controlled passage and the entrance passage leading to it, contain some minor guano deposits mixed with alluvium. The name of the cave is derived from a bedrock arch, 20 to 50 centimeters in diameter, that extends from the west wall of the inland passage.

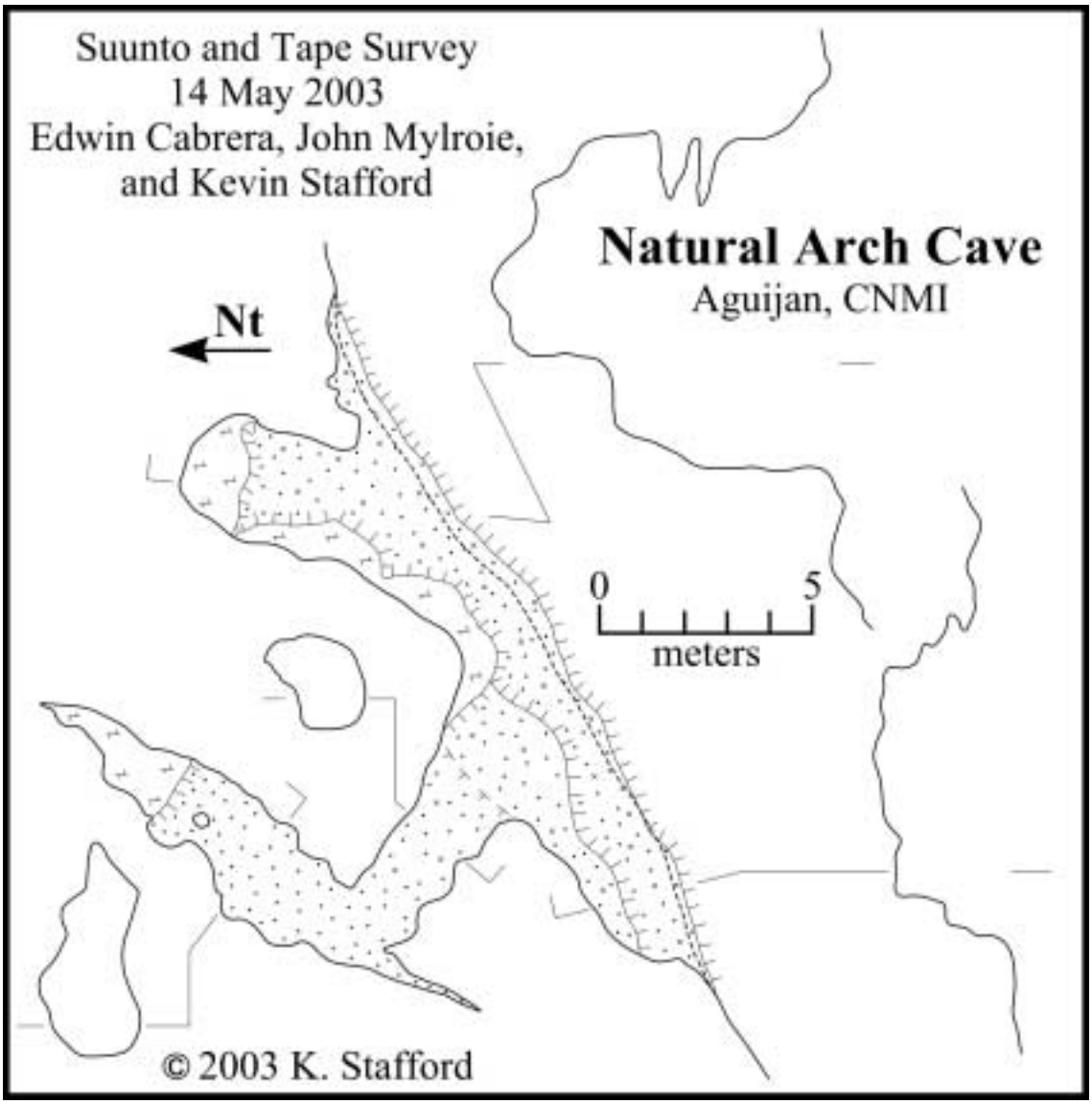

Figure 116: Map of Natural Arch Cave.

North Unai Dangkolo (Median Valley, Tinian – Figure 117)

North Unai Dangkolo is the northern scarp of Unai Dangkolo and the two coves north of it. It is developed in the Mariana Limestone (QTmca) and covers 300 meters of coastline. The northern most cove has a width of 50 meters and extends inland 20 meters with ceiling remnants extending from the wall less than 5 meters for the majority of the cove, which is floored with carbonate sand. The main cove at North Unai Dangkolo has a seaward width of 85 meters and extends inland 95 meters with the width decreasing to 25 meters at a distance of 35 meters inland. Small regions are roofed near the cove walls and minor amounts of well-weathered flowstone can be seen in places. The entire cove is floored with carbonate sand with several large collapse blocks located on the north and south side of cove near the shoreline. Several prominent fractures are dissolutionally widened throughout the cove and a 15-meter long, 3-meter wide, 1-meter tall pillbox is constructed in the northeast corner of the cove. The northern scarp of Unai Dangkolo is 90 meters south of this large cove and extends inland 60 meters before it turns south into dense vegetation, which prevented a continuation of the survey along the perimeter of Unai Dangkolo. However, Andyland cave was located at this southward bend in the cove. The majority of North Unai Dangkolo is floored with carbonate sand, but dense vegetation grows in the regions that are farther inland and more protected from normal coastal processes.

Northern Playground Cave (Southeastern Ridge, Tinian – Figure 118)

Northern Playground Cave is located in the southeast region of the Piña ridge and consists of two caves developed in the Mariana Limestone (QTmu). The larger cave has an entrance 5 meters wide that is 6 meters tall and extends inland 6 meters with a 2-meter wide and 2.5 meters tall passage extending from the southwest corner of the main chamber for 4 meters. The smaller cave is located 4 meters northeast of the larger cave and extends inland 4.5 meters with an average width of 3 meters and ceiling height of 2 meters. The majority of the cave is floored with soil and detritus, but a small ledge in northern portion of the larger cave is bedrock as is the passage extending from the southwest corner of the larger cave.

Nuestra Señora de Santa Lourdes Cave Complex
(Central Plateau, Tinian – Figure 119)

This cave complex, including the Nuestra Señora de Santa Lourdes shrine located at feature "C", consists of a series of flank margin caves that developed on a consistent horizon and were modified for use during World War II. This series of caves is developed in the Mariana Limestone (QTmu) and have been breached by cliff retreat at the boundary between the Median Valley and Central Plateau. The caves vary in size and degree of human modification. Features A, C and D are typical flank margin caves with minor excavation to their floors, while the ceilings and walls appear to have been modified little, except for feature C, which has two small side passages that where excavated. Feature B has been highly modified leaving little evidence of the original floor, ceiling or walls, making its origin unclear. Feature E is extensively modified, including cement floor and supporting walls, as well as widened regions that are reinforced with concrete. It is doubtful that much of this feature is of original dissolutional origin, because of the constant height of the chamber at 1.6 meters and the extensive talus debris located outside its eastern entrance. In addition to the modifications during the World War II Japanese occupation, feature C has a modified floor of limestone aggregate and a cement shrine it the center.

Figure 117: Map of North Unai Dangkolo.

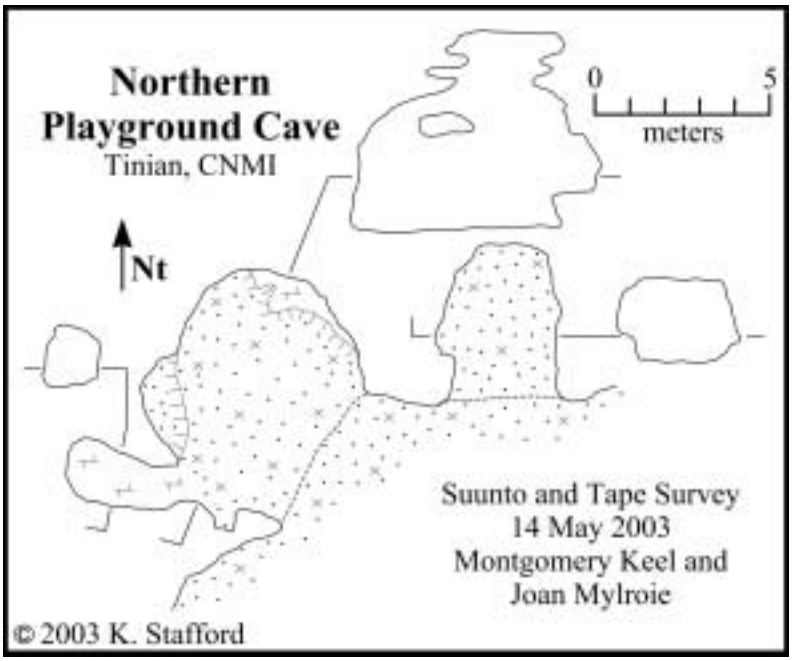

Figure 118: Map of Northern Playground Cave.

Orange Cave (Central Plateau, Tinian – Figure 120)

Orange Cave is located 700 meters west/southwest of Puntan Diapblo in the Mariana Limestone (QTmu). This breached, flank margin cave has an entrance 14 meters wide and extends inland 16 meters with an average ceiling height of 3 meters. The cove is a single chamber that has been severely impacted by intense storm events, creating a floor covered in well-worn breakdown blocks and cobbles.

Orphan Kids Cave Complex (Lower Terrace, Aguijan – Figure 121)

Orphan Kids Cave Complex is developed in the Mariana Limestone (QTmu) and located on the Lower Terrace on the southern side of Aguijan. This feature consists of three caves spread approximately 75 meters along a low cliff face. The caves are developed along a northwest trending fault with a dips approximately 35^{o} to the northeast. The three caves contain extensive speleothems and breakdown, with the northern feature extending to a depth of 4 meters and the middle and southern feature extend to 17 meters depth. All three features show evidence of extending to greater depths, but collapse and breakdown prevented further exploration. In association with these features, there are numerous dissolutionally enhanced surface fractures, which follow the same general trend. However, no additional features were located that could be entered by humans, nor any that showed signs of speleothems.

Pebble Cave (Central Plateau, Tinian – Figure 122)

Pebble Cave is located 700 meters southeast of Puntan Atgidon in the Mariana Limestone (QTmu). It is a flank margin cave remnant located less than 1 meter above sea level in the northeastern portion of a large cove referred to locally as Mendiola Cove after the landowner. The entrance of the cave is 22 meters wide and 7 meters tall, with the cave extending inland 9 meters. The cave is floored with carbonate sand and pebble size carbonate clasts, in addition to several large breakdown blocks, which appear to be remnants of the collapsed ceiling located in the southern part of the cave.

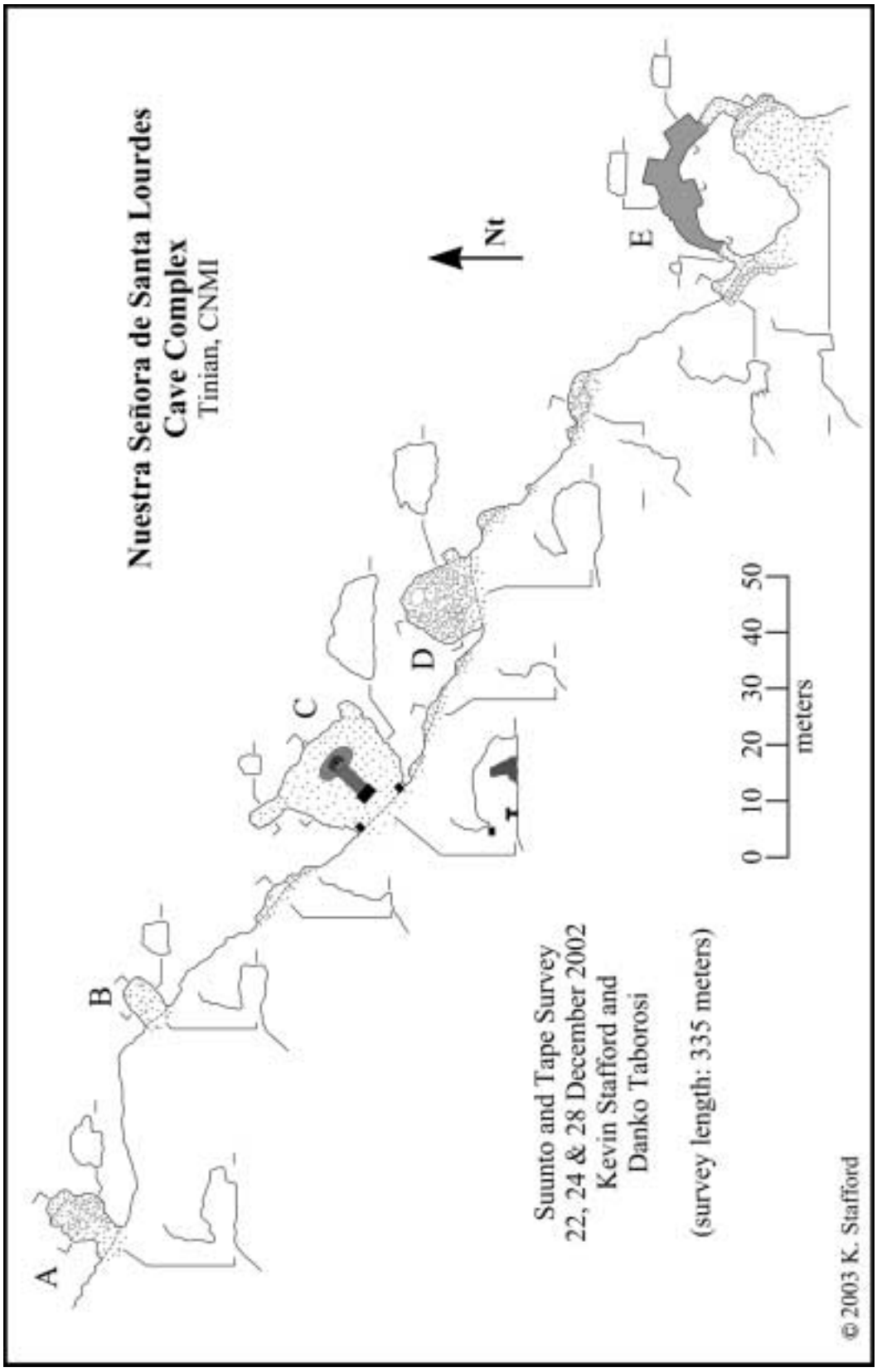

Figure 119: Map of Nuestra Señora de Santo Lourdes Cave Complex.

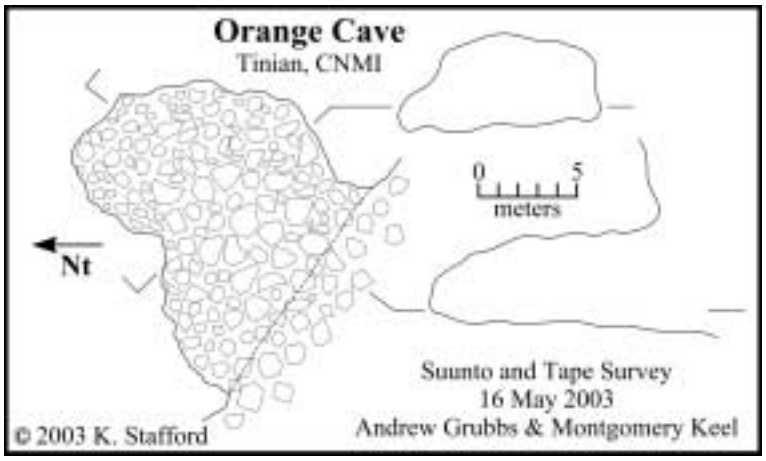

Figure 120: Map of Orange Cave.

Pepper Cave (Upper Terrace, Aguijan – Figure 123)

Pepper Cave is a small flank margin cave located in the northwest portion of the Upper Terrace in the Mariana Limestone (QTmu). It consists of a single chamber 5 meters wide, 3 meters deep and less than 2 meters tall. The floor is composed of alluvium and minor human modification consisting of a 6-meter long rock wall, which extends from the northern side of the entrance to the southeast.

Piña Cave Complex (Southeastern Ridge, Tinian – Figure 124)

Piña Cave Complex is located in the southeastern region of the Piña ridge and consists of three caves developed in the Mariana Limestone (QTmu). The larger cave is located at the southern end of this scarp segment and consists of three primary parts. The entrance area is 6 meters wide and extends inland, to the north for 5 meters forming the soil and detritus floored, entrance chamber. From the entrance chamber, a bedrock-floored passage extends 8 meters to the west as an upper level passage. To the south, a passage extends 4 meters and terminates in an elevated ledge. The two other caves are small and located 38 meters northeast of the larger cave. These two small caves are 3 meters apart with the western cave developed 2 meters high on the scarp and the eastern cave developed at the base of the scarp. Both caves extend inland 2 meters with ceiling heights less than 2 meters. The western cave exhibits a bedrock floor and the eastern cave has a soil, detritus and breakdown floor.

Playground Cave (Southeastern Ridge, Tinian – Figure 125)

Playground Cave is located in the southeast region of the Piña ridge and is composed of two caves along a scarp segment that is developed in the Mariana Limestone (QTmu). The larger cave extends inland to the west with an entrance 13 meters wide and a 1-meter by 2-meter bedrock column located in southern part of the entrance. It reaches its largest dimension in the northern part of this cave, where it extends inland 7 meters with a ceiling height of 9 meters. A smaller passage, 2 meters wide, extends west from the larger cave for 4 meters. In this larger portion, a collapsed rock wall is present which indicates human modification of the feature, but the remainder of the cave has a soil and detritus floor. The smaller cave is 8 meters northeast of the larger cave and has two entrances separated by a 2-meter diameter bedrock column. The west entrance leads to a small passage that is 1 meter tall, while the east passage has a ceiling height of 7 meters and extends to the north, roughly parallel to the scarp face, for 4.5 meters, forming the majority of this smaller cave.

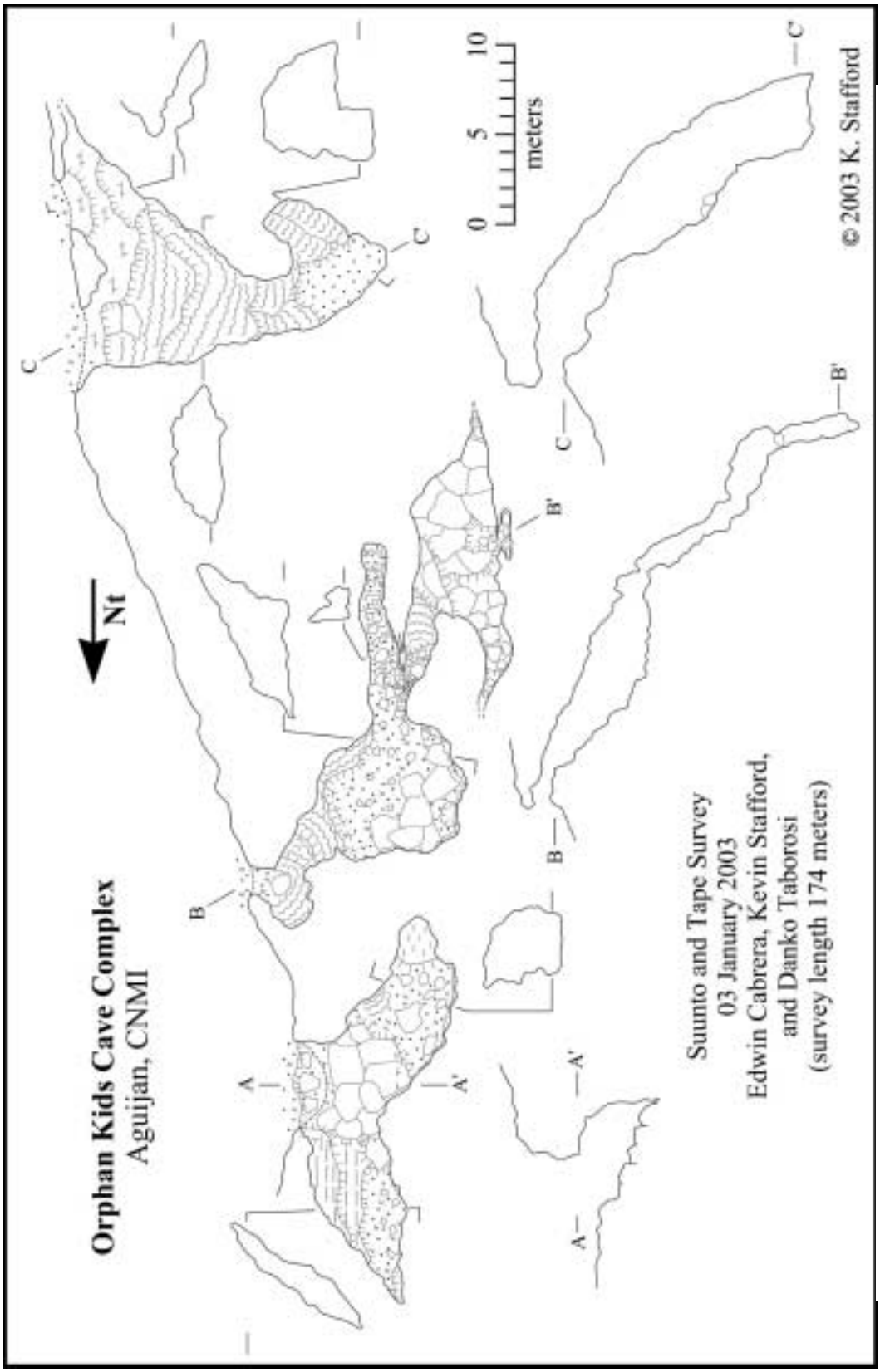

Figure 121: Map of Orphan Kids Cave Complex.

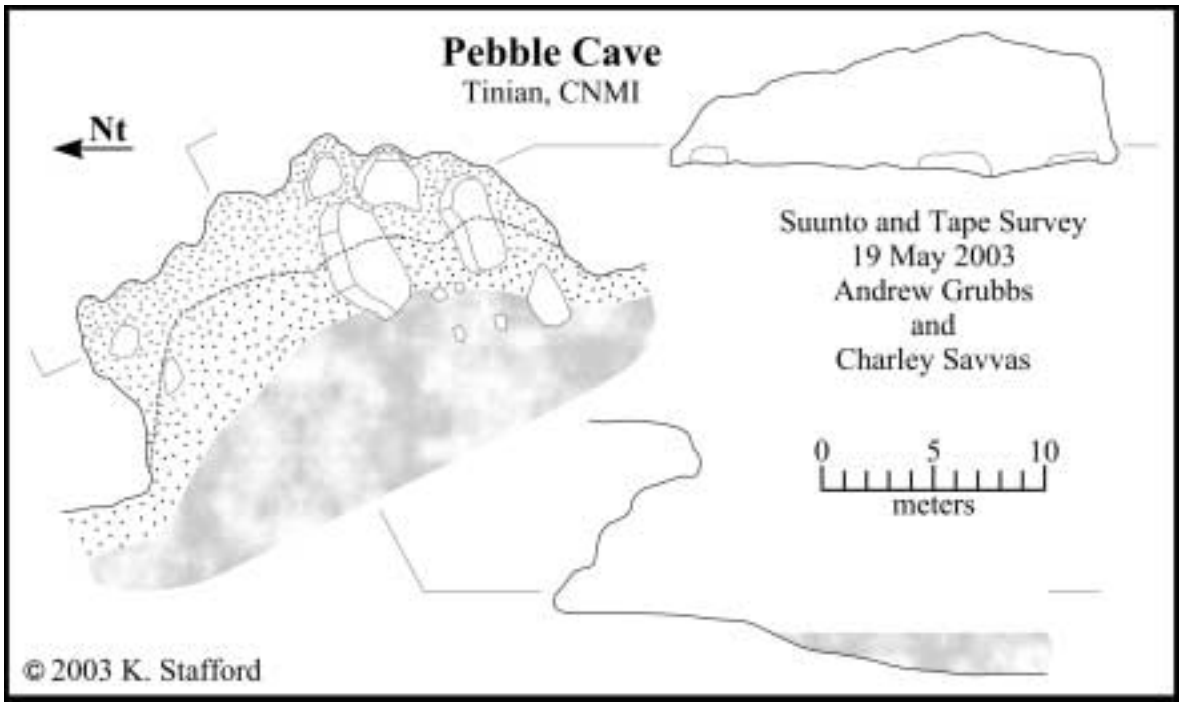

Figure 122: Map of Pebble Cave.

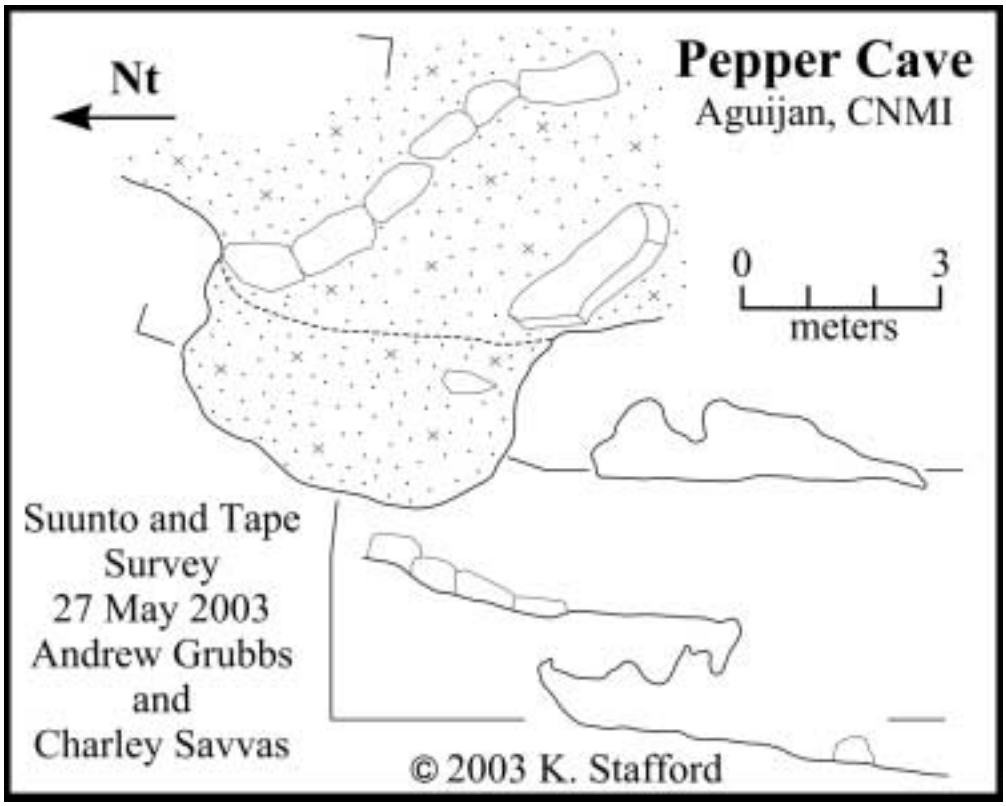

Figure 123: Map of Pepper Cave.

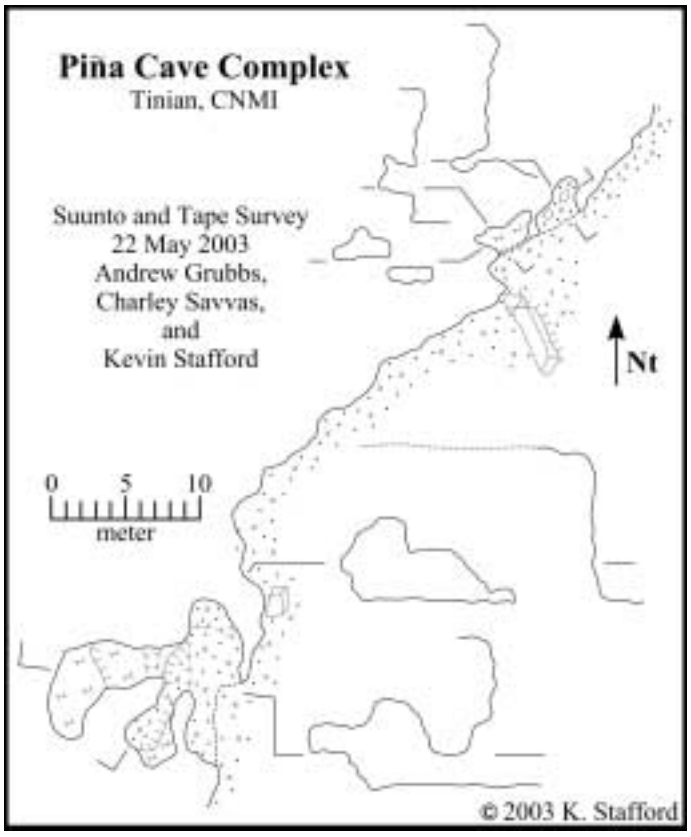

Figure 124: Map of Piña Cave Complex.

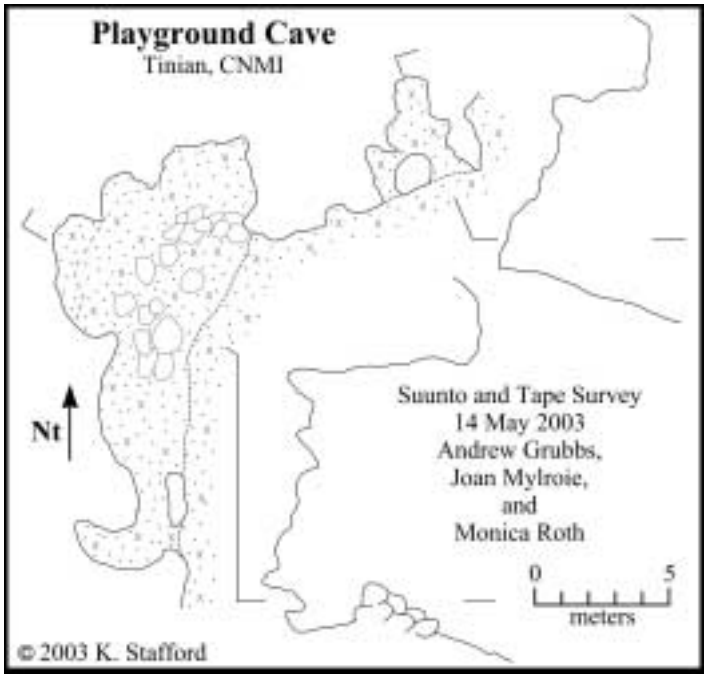

Figure 125: Map of Playground Cave.

Plunder Cave (Median Valley, Tinian – Figure 126)

Plunder Cave is located near the Water Cave, approximately 2 kilometers south of Taga Beach and 300 meters inland from the west coast. It is developed at the boundary between the Median Valley and the Southeastern Ridge provinces along a northeast/southwest trending fault that dips at approximately 35° to the southeast. This dissolutionally enlarged fracture cave is formed in the Mariana Limestone (QTmu) and is approximately 43 meters by 12 meters, extending to a depth of 13 meters. The cave consists primarily of one large chamber that contains extensive speleothems and much breakdown. In the central parts of the cave, a small, lower chamber is present in the breakdown blocks, where stacking of collapse material has created a larger void that is humanly passable. In the northern parts of the cave, large breakdown blocks have been covered by massive speleothem accumulations, but void space beneath these blocks has left a smaller passage. On the map, locations marked 1, 2, and 3 represent locations where geologic specimens were taken for future isotope analysis.

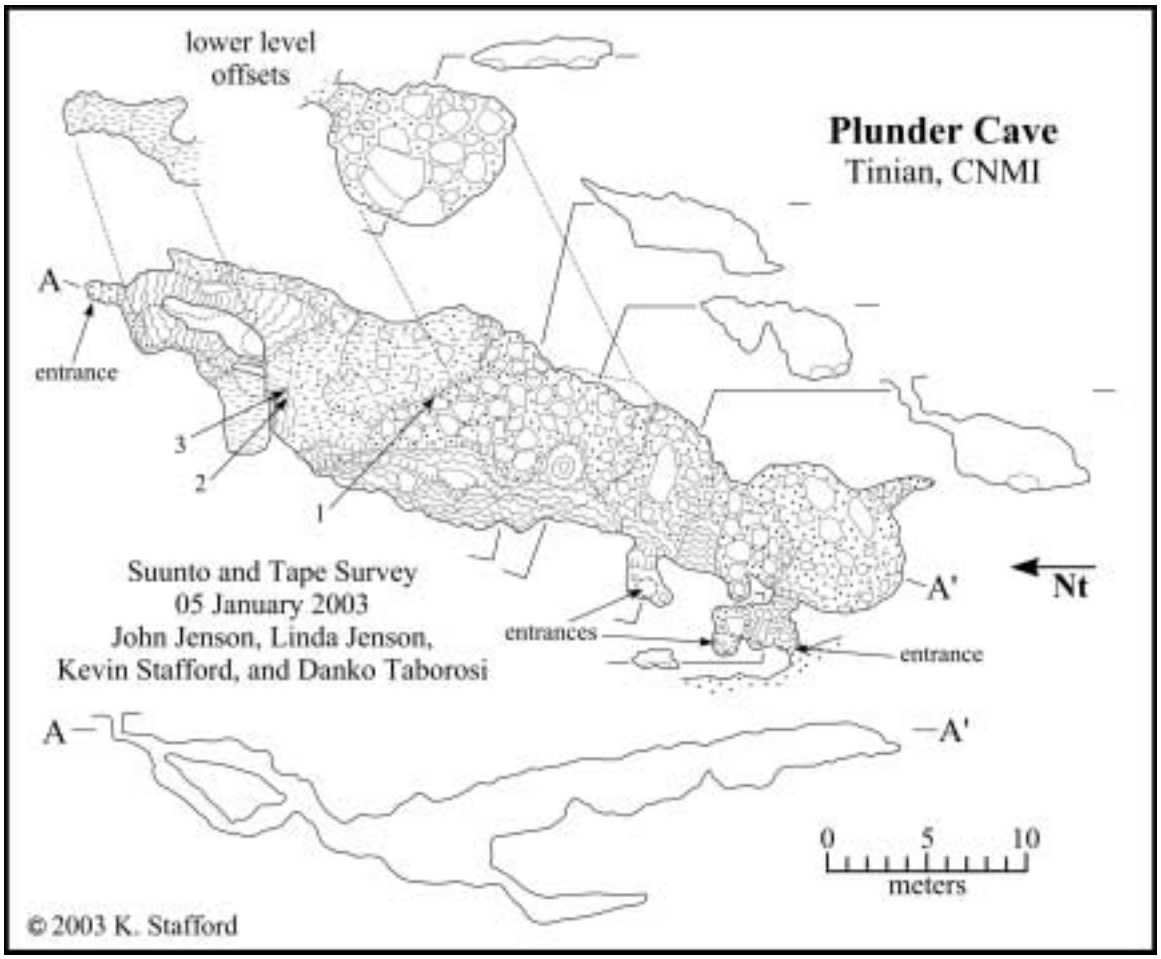

Figure 126: Map of Plunder Cave.

Radio Inactive Cave (Southeastern Ridge, Tinian – Figure 127)

Radio Inactive Cave is located in the central region of Suicide Cliffs in the Mariana Limestone (QTmu). It is a flank margin cave remnant that has been breached by scarp retreat with a 13-meter wide cliff entrance and a 2-meter diameter pit entrance in the inland part of the

cave. The cave extends 21 meters inland with an average ceiling height of 3 meters, forming a chamber with an average width of 7 meters that is partially divided by three bedrock columns. The scarp entrance area has a bedrock floor with some speleothems, primarily has stalagmites and columns. In the inland areas, near the pit entrance, the cave has fewer speleothems and the floor is covered with alluvium. The cave has been slightly modified by humans with some leveling of alluvial floors and deteriorating wooden floors. The cave is named for a Japanese military radio that was found in the there.

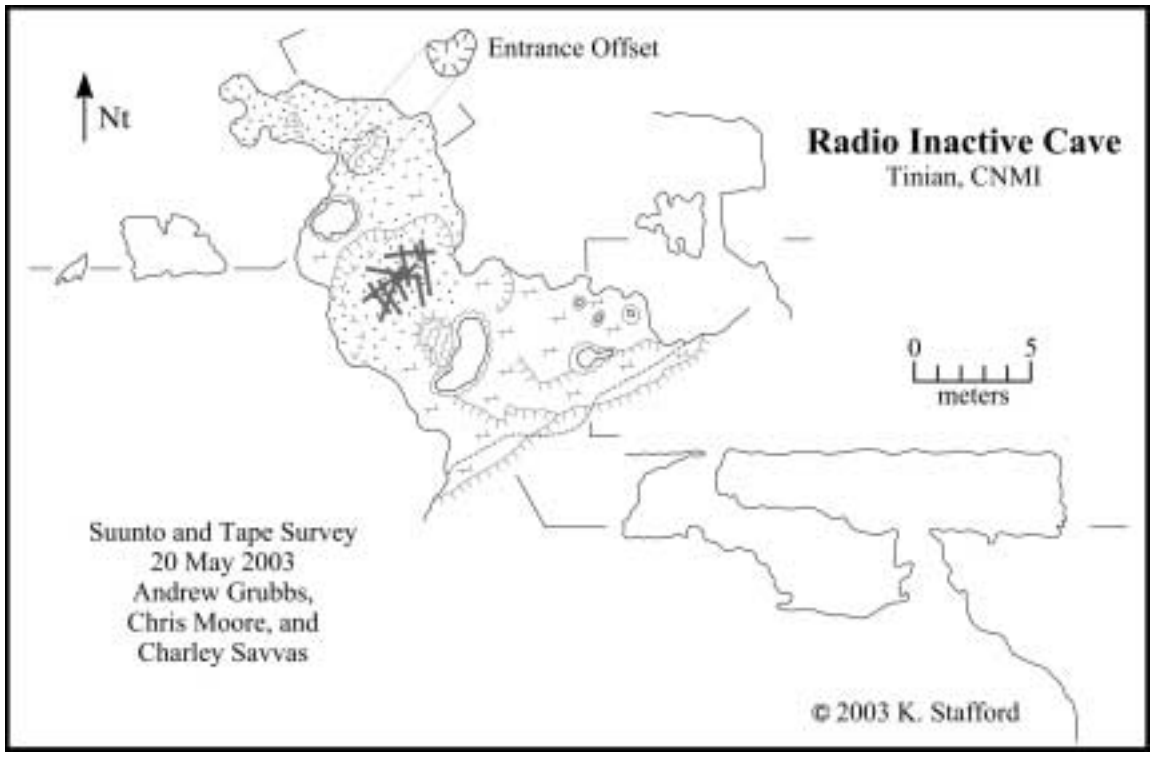

Figure 127: Map of Radio Inactive Cave.

Red Snapper Cave (Central Plateau, Tinian – Figure 128)

Red Snapper Cave is located 900 meters south of Puntan Lamanibot Sampapa at the top of the coastal scarp in the Mariana Limestone (QTmu). It is a collapsed, flank margin cave remnant similar to the coves seen near Unai Dangkolo, except that it is 10 meters above sea level without a carbonate sand floor. The feature is divided by a large bedrock remnant on the coastal scarp side, which forms two collapsed entrances 11 and 16 meters wide. The feature extends inland 43 meters, decreasing in depth inland but averaging 4 meters. The most inland 5 meters remains roofed, as do several smaller regions on the periphery of the feature where bedrock pillars provided additional support for the roof. Several small terraces subdivide the feature, while the floor is primarily composed of bedrock with scattered breakdown blocks that appear to be remnants of the original roof. Speleothem deposits, including flowstone, stalactites and stalagmites are seen throughout, but are more abundant in the areas that still retain protective ceiling remnants. The feature, although located well above mean sea level, appears to have been heavily impacted by numerous intense storm events and is primarily devoid of vegetation.

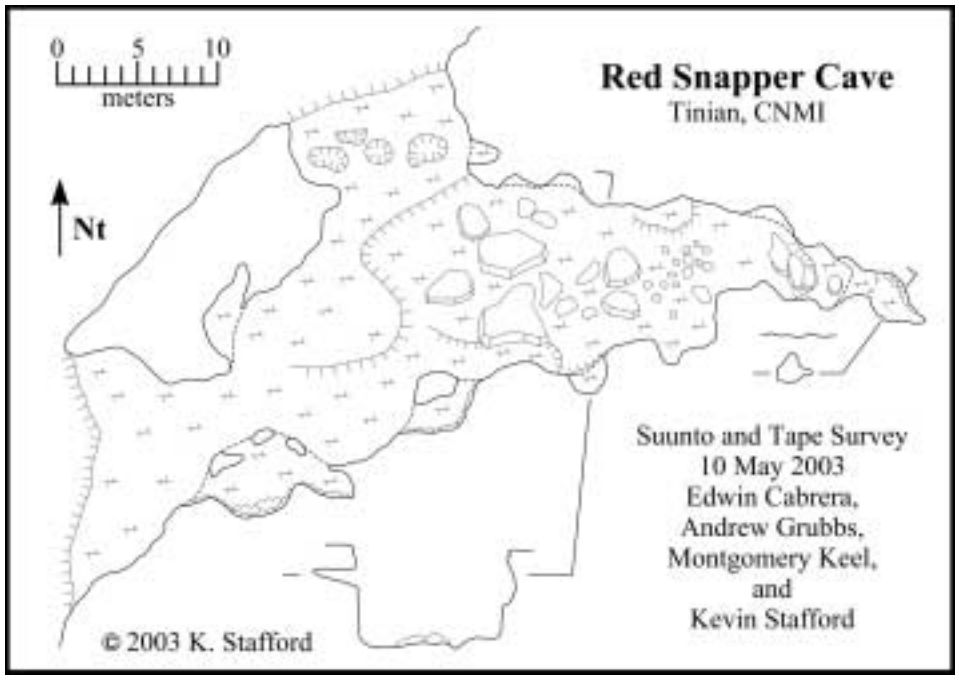

Figure 128: Map of Red Snapper Cave.

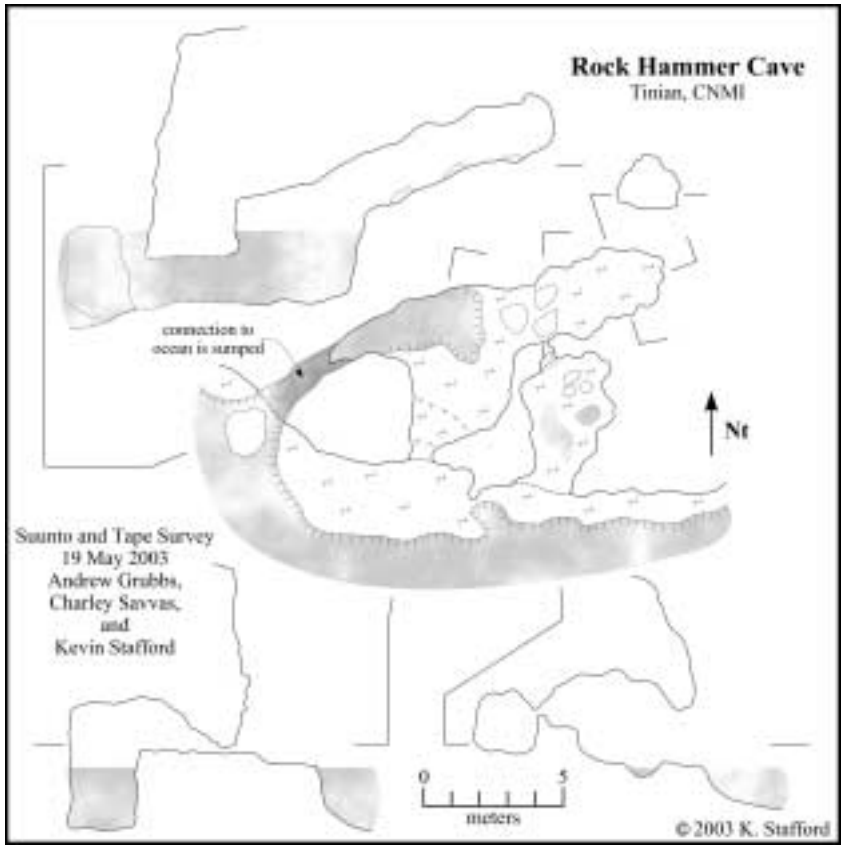

Figure 129: Map of Rock Hammer Cave.

Rock Hammer Cave (Central Plateau, Tinian – Figure 129)

Rock Hammer Cave is a flank margin cave located 900 meters southeast of Puntan Atgidon in the Mariana Formation (QTmu). It is positioned 1 meter above mean sea level at a prominent headland in the cove locally referred to as Mendiola Cove after the landowner. The cave is breached at three locations, with one entrance submerged below sea level. The most prominent entrance is 2 meters wide and trends inland as a single chamber for 5 meters, where it is connected to the main cave chamber by a small, 20-centimeter wide passage. The main chamber has two entrances; the western entrance is located 1 meter below sea level and was not entered because of strong surf conditions, while the second entrance is located between the sumped entrance and the prominent entrance. This second entrance was partially blocked at the time of discovery, but with minor removal of bedrock, it was enlarged to allow entry through a 40-centimeter tall crawlway. The crawlway opens less than 1 meter inland into a 2-meter tall passage, which extends east for 10 meters connecting to the prominent entrance chamber. The west side of the main chamber drops below sea-level near-vertically into a pool of water 5 meters long and 2 meters wide. The entire feature is primarily retains a bedrock floor, excluding some breakdown blocks. Few speleothem deposits were seen in the cave, but the cave is a good example of how flank margin cave chambers that barely connected to each other and the surface.

Rogue Cave (Northern Lowland, Tinian – Figure 130)

Rogue Cave is located 150 meters northeast of Unai Lamlam on the northwest coast. It is a discharge type feature developed in the Mariana Limestone (QTmu), extending inland 9 meters from a cove 31 meters wide and 19 meters deep. The majority of the cave is below sea level, but a bench up to 7 meters wide extends from the cave with partially roofed sections. The cave consists of a chamber 3 meters in diameter that extends below sea level 1.5 meters and a smaller tube that extends inland from the chamber 6 meters at 2 meters above sea level. The smaller tube has a distinct fracture or joint, which runs through the ceiling and floor, while a larger, dissolutionally widened fracture extends from the entrance below sea level. The feature showed some indication of freshwater discharge below sea level, but due to strong surf conditions a positive identification of discharge was not possible. However, based on the morphology of the cave and the distinct joint in the floor and ceiling, this feature is classified as a discharge feature.

Rootcicle Cave (North-Central Highland, Tinian – Figure 131)

Rootcicle cave is a collapsed banana hole feature that is developed in the Mariana Limestone (QTmca). This feature is located approximately 300 meters northeast of the Lasso Shrine at Mt. Lasu on a small terrace level above the Laderan Mangpang scarp. This feature has a central entrance formed by collapse and is elongated in a northwest/southeast direction, with dimensions of 10 meters by 33 meters. Through the long axis of the cave, there is a fault trending 120^{o}-130^{o} and dipping approximately 75^{o} to the southeast. The fault has dropped the southern portion of the cave by approximately 2 meters relative to the northern portions. This fault trend extends to the east as a low passage that is not humanly passable. The cave contains numerous speleothems as well as large amounts of breakdown and talus associated with the entrance collapse.

Scorpion Cave (Middle Terrace, Aguijan – Figure 132)

Scorpion Cave is a small flank margin cave located in the north-central region of the Middle Terrace in the Mariana Limestone (QTmu). It extends inland 11 meters with a maximum width of 9 meters and average ceiling height of 2 meters. The northern and western parts of the cave are slightly elevated with bedrock floors, while the main chamber contains an alluvial floor with three large breakdown blocks. Narrow dissolutional features extend up to two meters into

the ceiling in the western part, while a narrow passage extends from the southern edge of the main chamber. The cave was named after a 5 mm long scorpion found during the survey.

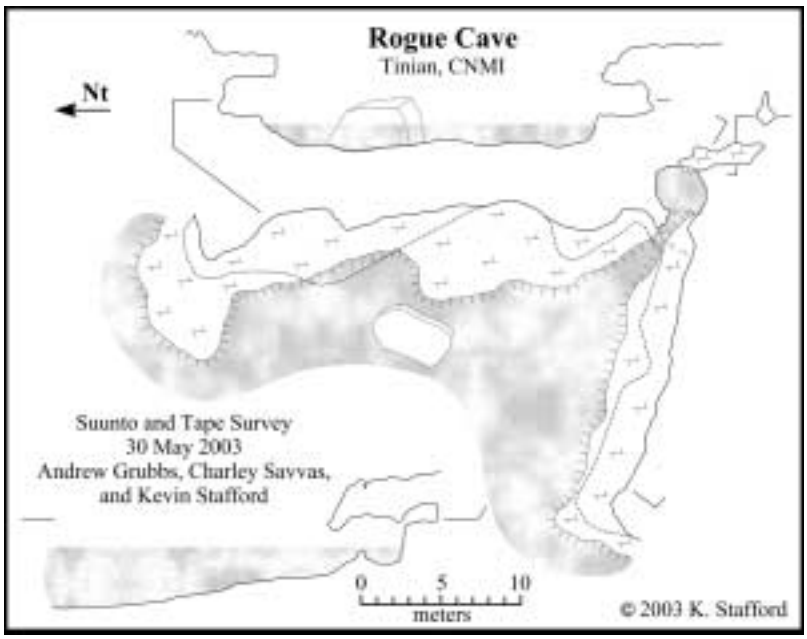

Figure 130: Map of Rogue Cave.

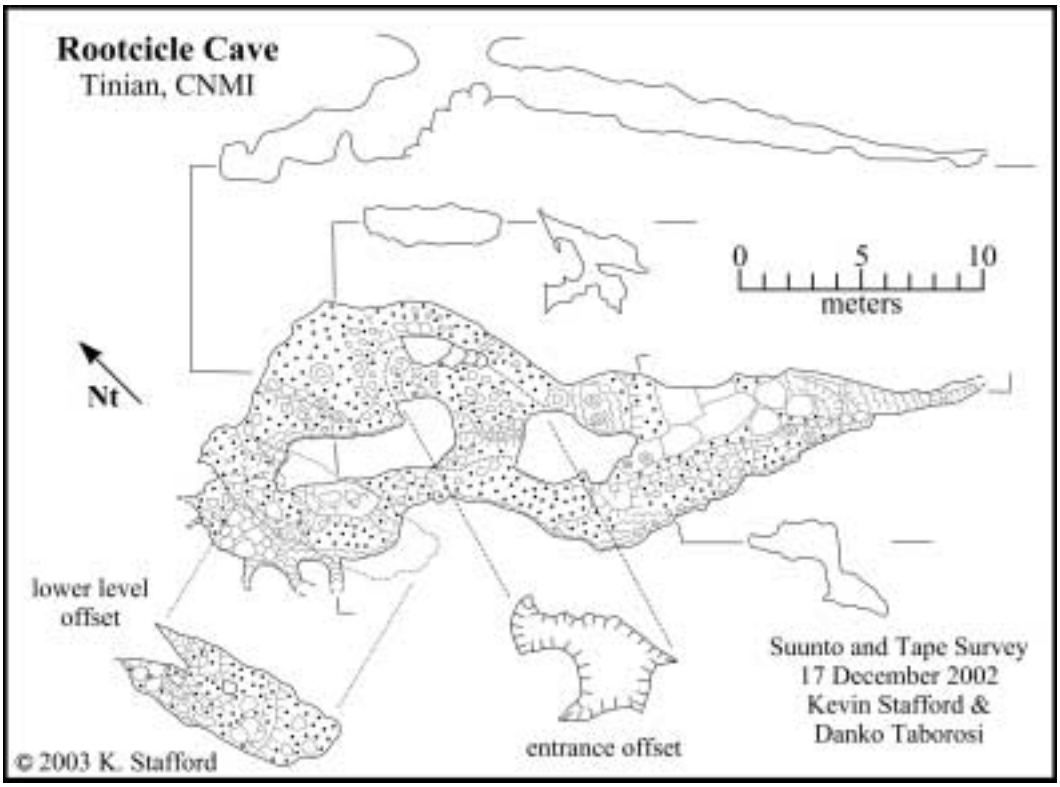

Figure 131: Map of Rootcicle Cave.

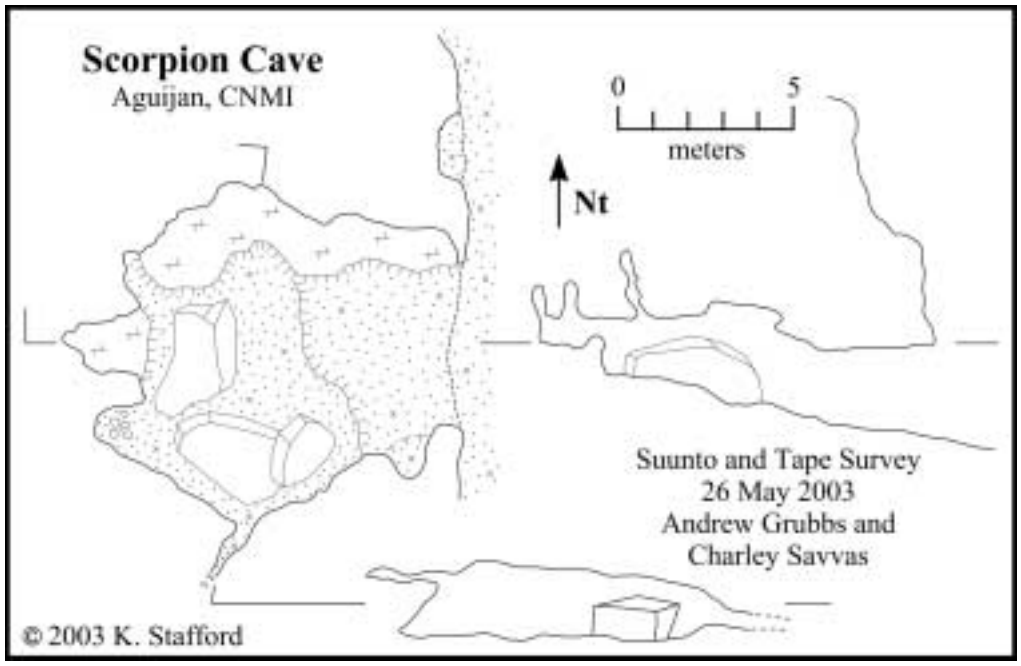

Figure 132: Map of Scorpion Cave.

Screaming Bat Cave (Upper Terrace, Aguijan – Figure 133)

Screaming Bat Cave consists of two flank margin cave remnants in the northwest region of the Upper Terrace in the Mariana Limestone (QTmu). Both cave remnants extend to the west approximately 5 meters, with an average width of 2 meters. The floor in the northern cave remnant is primarily alluvium, while the floor in the southern cave remnant is primarily bedrock. The name of the cave is derived from fruit bats that were feeding on breadfruit trees in the region at the time of survey.

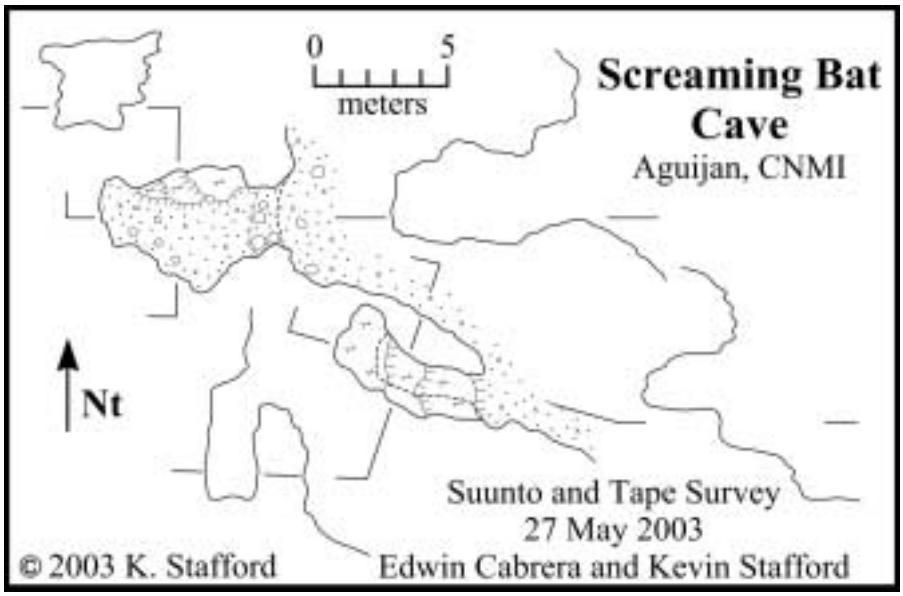

Figure 133: Map of Screaming Bat Cave.

Skip Jack Cave (Southeastern Ridge, Tinian – Figure 134)

Skip Jack Cave is located 1500 meters northwest of Puntan Carolinas on the west coast at sea level. It is a breached, flank margin cave consisting of two primary chambers developed in the Mariana Limestone (QTmu). The entrance chamber is 18 meters wide and extends inland 14 meters, with a height above sea level of 8 meters and depth below sea level of 5 meters. Several small passages extend from this entrance chamber along fractures oriented north/south, while the second chamber extends inland 25 meters from the northeast corner of the entrance chamber. The second chamber ascends above sea level with an average width of 13 meters and height of 5 meters. The second chamber contains several large breakdown blocks covering a bedrock floor with a large mound of flowstone along the western edge of the chamber. This cave is not easily accessed from the surface, but requires a coastal swim from a small inlet located 400 meters north of the feature.

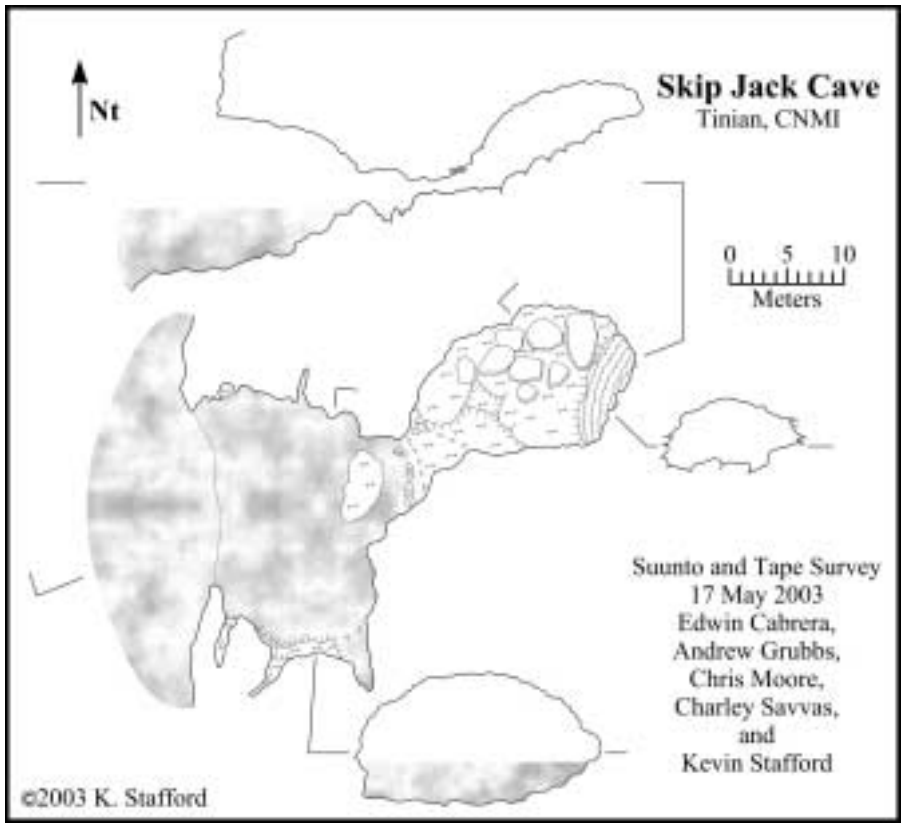

Figure 134: Map of Skip Jack Cave.

Skull Cave Complex (Southeastern Ridge, Tinian – Figure 135)

Skull Cave Complex is located in the southeastern region of the Piña ridge in the Mariana Limestone (QTmu). It consists of three flank margin cave remnants that extend inland to the west. The southern cave in the complex is located 2.5 meters high on the scarp and extends inland 3 meters with a bedrock floor with a ceiling height of 1.5 meters and an entrance width of 8 meters. The middle cave in the complex is 1.5 meters wide at the entrance, then widens to 8 meters and extends inland 5 meters. This middle cave has a large breakdown block, partially concealing the 1-meter tall entrance, which then increasing to 2.5 meters tall with a soil and detritus floor and a small bedrock ledge in the southwest corner. The largest cave is located at the

northern edge of the complex and consists of soil and detritus floored chamber that extends inland 10 meters with an average width of 8 meters. The entrance area consists of three breached entrances; two at ground level and one 2 meters above the ground surface. This cave is named for the skull-like appearance of the three entrances. The entire complex shows minor human modification primarily in the form of leveled floors.

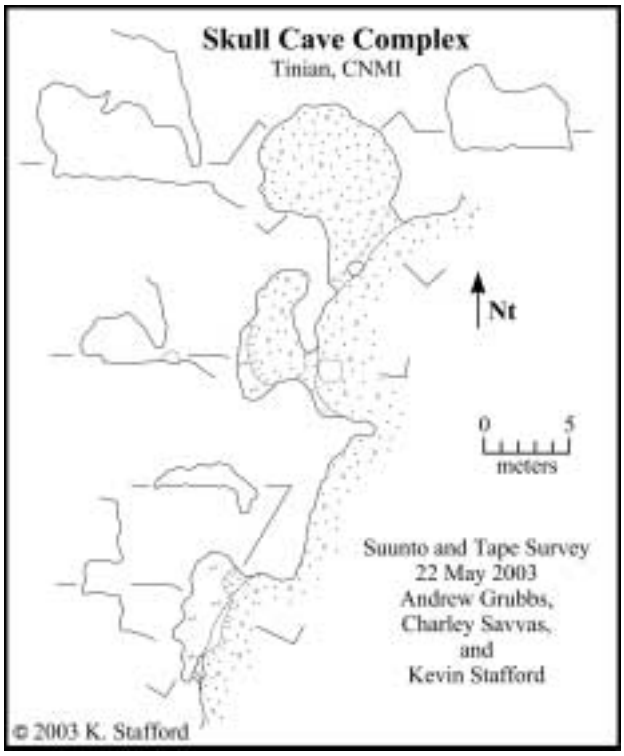

Figure 135: Map of Skull Cave Complex.

Skylight Cave (Southeastern Ridge, Tinian – Figure 136)

Skylight Cave is located in the central region of Suicide Cliffs in the Mariana Limestone (QTmu). The cave is located 5 meters below the top of the cliff with a cliffside entrance that is 9 meters wide and 2 meters tall. The cave extends inland 12 meters with and average width of 4 meters before it is breached on the inland side by ceiling collapse. The cave contains several speleothem columns as well as a large flowstone mound along the eastern side. The inland part contains several large breakdown blocks and a soil and detritus floor, while the regions near the cliff edge contain a bedrock floor. The feature is primarily a linear passage extending inland to the north, with several small solutional pockets that extend east and west of the main cave.

Solitary Cave (Southeastern Ridge, Tinian – Figure 137)

Solitary Cave is located 1500 meters south of Unai Masalok, is the only cave that has been identified on the western scarp of Piña ridge. This small, flank margin cave remnant is developed in the Mariana Limestone (QTmu). The cave has and entrance 2 meters wide, extends inland 2 meters and widens to 3 meters with a ceiling height of 1.5 meters. The cave appears to have been extensively modified, including some enlargement of the cave and the construction of a rock wall 2.5 meters long and 1 meter tall, which conceals the majority of the entrance. This feature was not surveyed at the time of discovery, because it was the only feature located during

the exploration of this region and a survey crew did not return to the region in order to survey this small, solitary feature.

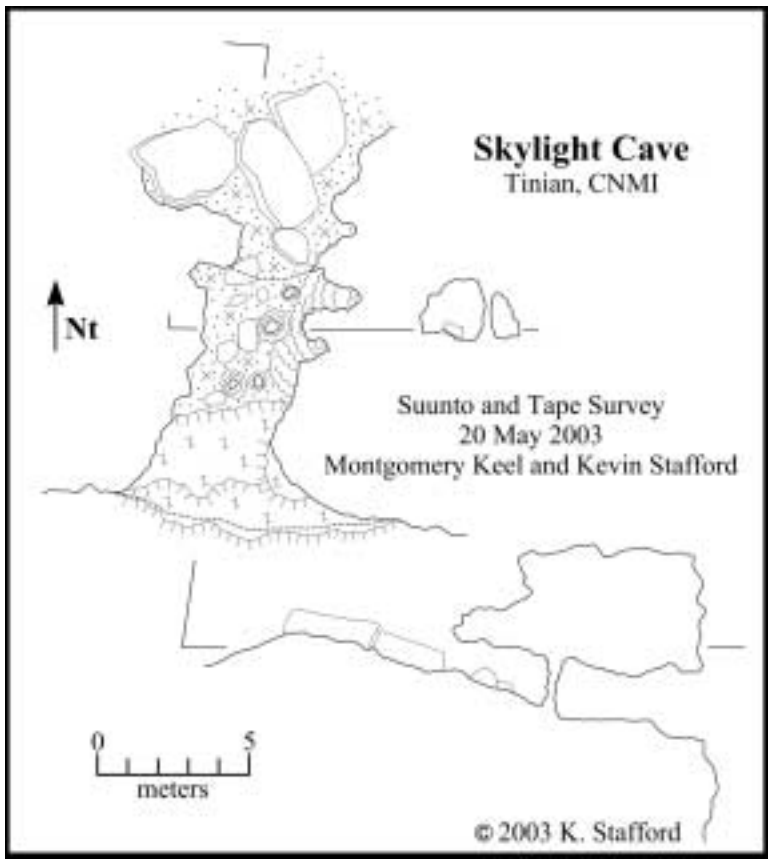

Figure 136: Map of Skylight Cave.

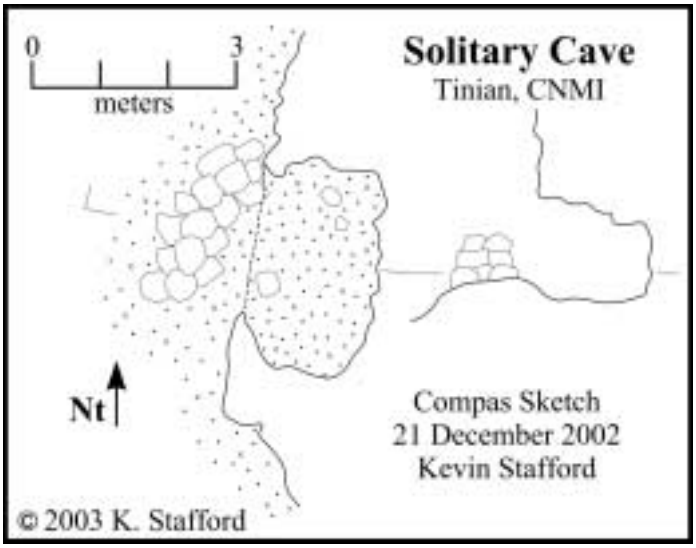

Figure 137: Map of Solitary Cave.

South Mendiola Cave (Central Plateau, Tinian – Figure 138)

South Mendiola Cave is located 1200 meters north of Puntan Diapblo at the southern end of a large cove referred to as Mendiola Cove after the landowner. The cave is a large, flank margin cave developed in the Mariana Limestone (QTmcc) at sea level. The cave has an entrance 40 meters wide and extends inland 48 meters with an average ceiling height of 8 meters. In the central part of the cave, there is a 10-meter diameter skylight entrance exists, while along the northern edge of the chamber a second entrance connects to the ocean below sea level. The cave is bedrock floored with numerous large and medium size breakdown blocks covering large areas of the floor.

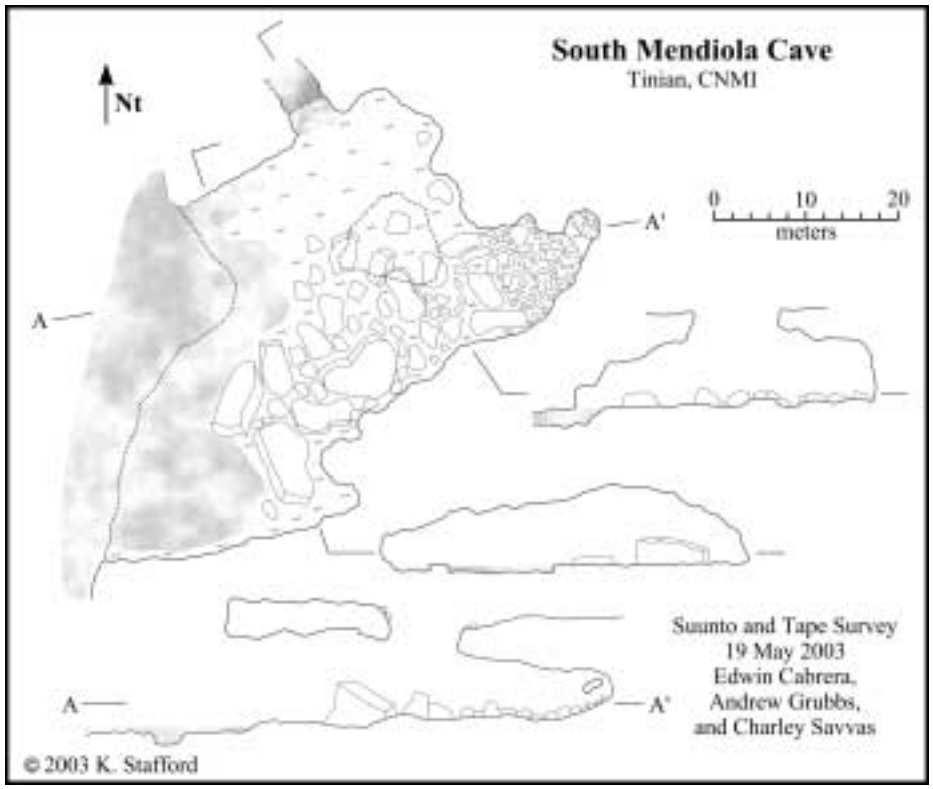

Figure 138: Map of South Mendiola Cave.

South Unai Dangkolo (Median Valley, Tinian – Figure 139)

South Unai Dangkolo is a large pocket beach developed in the Mariana Limestone (QTmca) just south of Unai Dangkolo and developed in the Mariana Limestone (QTmca). The feature is 20 meters by 40 meters and contains some small remnant cave chambers and speleothems, which indicate that this was originally a large flank margin chamber that has been breached by coastal processes including the removal of the majority of the roof. A small dissolutionally enhanced fracture connects this feature to Unai Dangkolo to the north, while a less developed extension of this same fracture extends to the south from the feature in the direction of Dripping Tree Fracture Cave. Although not surveyed during fieldwork, Unai Dangkolo, to the north, appears to have a similar flank margin cave origin, but is much larger and has been more extensively eroded by coastal processes.

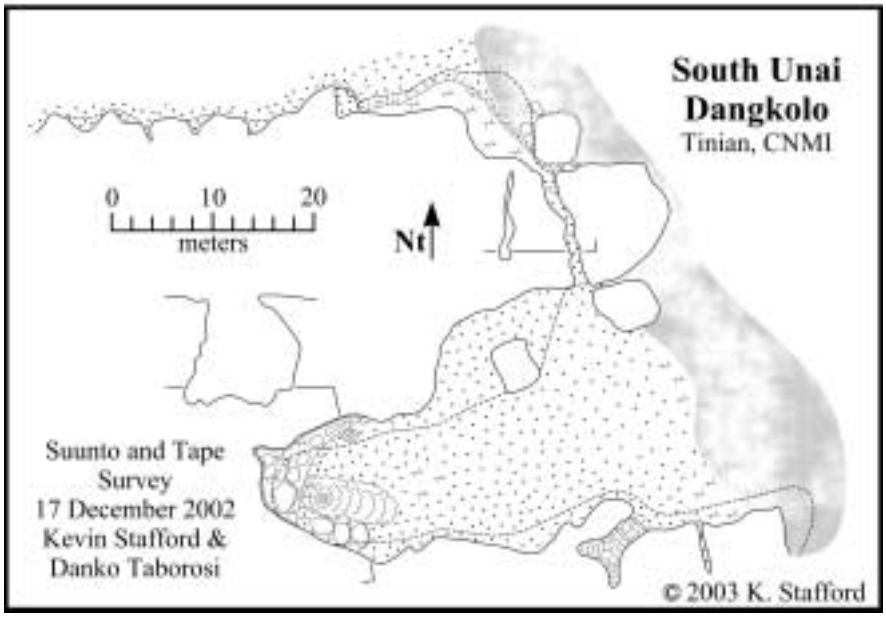

Figure 139: Map of South Unai Dangkolo.

Spider Cave (Middle Terrace, Aguijan – Figure 140)

Spider Cave is a small, breached flank margin cave located in north-central region of the Middle Terrace in the Mariana Limestone (QTmu). The cave has a maximum width of 8 meters exposed along the scarp entrance and extends inland up to 5 meters with a height ranging from 1 to 2 meters. The floor is composed of alluvium and is elevated in the central part of the opening and in the western part of the cave. The name is derived from several large spiders (~8 centimeters in diameter) that were present in the cave at the time of survey.

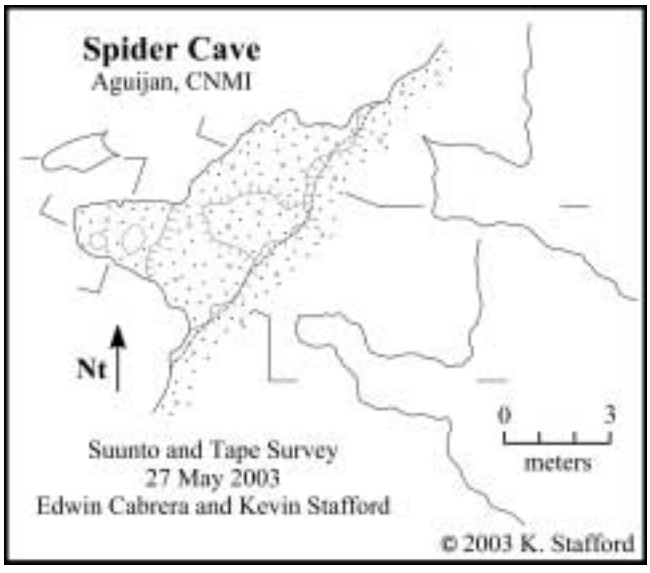

Figure 140: Map of Spider Cave.

Swarming Termites Cave (Middle Terrace, Aguijan – Figure 141)

Swarming Termites Cave is a breached, flank margin cave in the eastern region of the Middle Terrace in the Mariana Limestone (QTmu). The cave consists of three main parts, which extend from a 9-meter wide entrance. The northeast portion is a small chamber extending 3 meters inland, the north-central portion is a small passage extending 8 meters inland, and the southern portion is a small passage extending 13 meters inland. All three parts about 3 meters high at the entrance, reducing down to about 1-meter inland. The floor is composed of alluvium with scattered breakdown blocks. The cave appears to be the remnants of a larger flank margin cave, representing the "fingers" that would have extended off of the main chamber of the original cave. The cave is named after the large quantities of termites that were swarming in the region in the early evening.

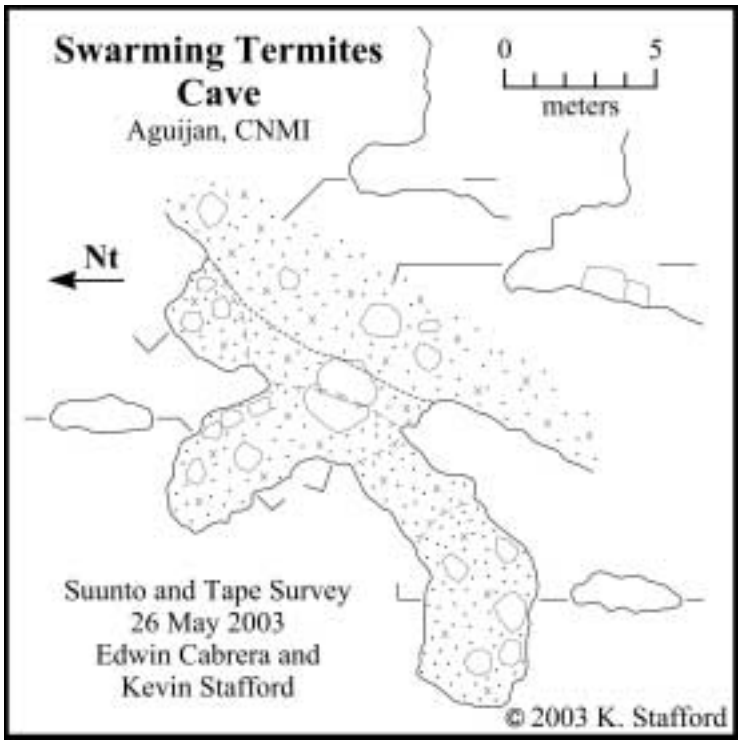

Figure 141: Map of Swarming Termites Cave.

Swiftlet Cave (Lower Terrace, Aguijan – Figure 142)

Swiftlet Cave is a large, breached flank margin cave on the northwest side of the Lower Terrace approximately 15 meters above sea level. It is developed in the Mariana Limestone (QTmu) and consists of a large chamber 70 meters wide and 30 meters deep that is approximately 18 meters tall in the roofed inland half of the main chamber. The ceiling of the main chamber contains extensive spelean and phototropic speleothems, while the floor is composed of alluvium and large breakdown blocks with elevated bedrock levels on the seaward (northern) side. In the western part of the cave, a passage 8 meters wide and 6 meters tall extends for 20 meters and contains extensive speleothem deposits in the inland portions. In the eastern portion of the cave a steeply dipping, fissure-like passage extends for approximately 50 meters with extensive speleothem deposits throughout and a large colony of Mariana Swiftlets occupying the elevated areas. This eastern extension connects to the main chamber through three small passages, which are reached by short climbs.

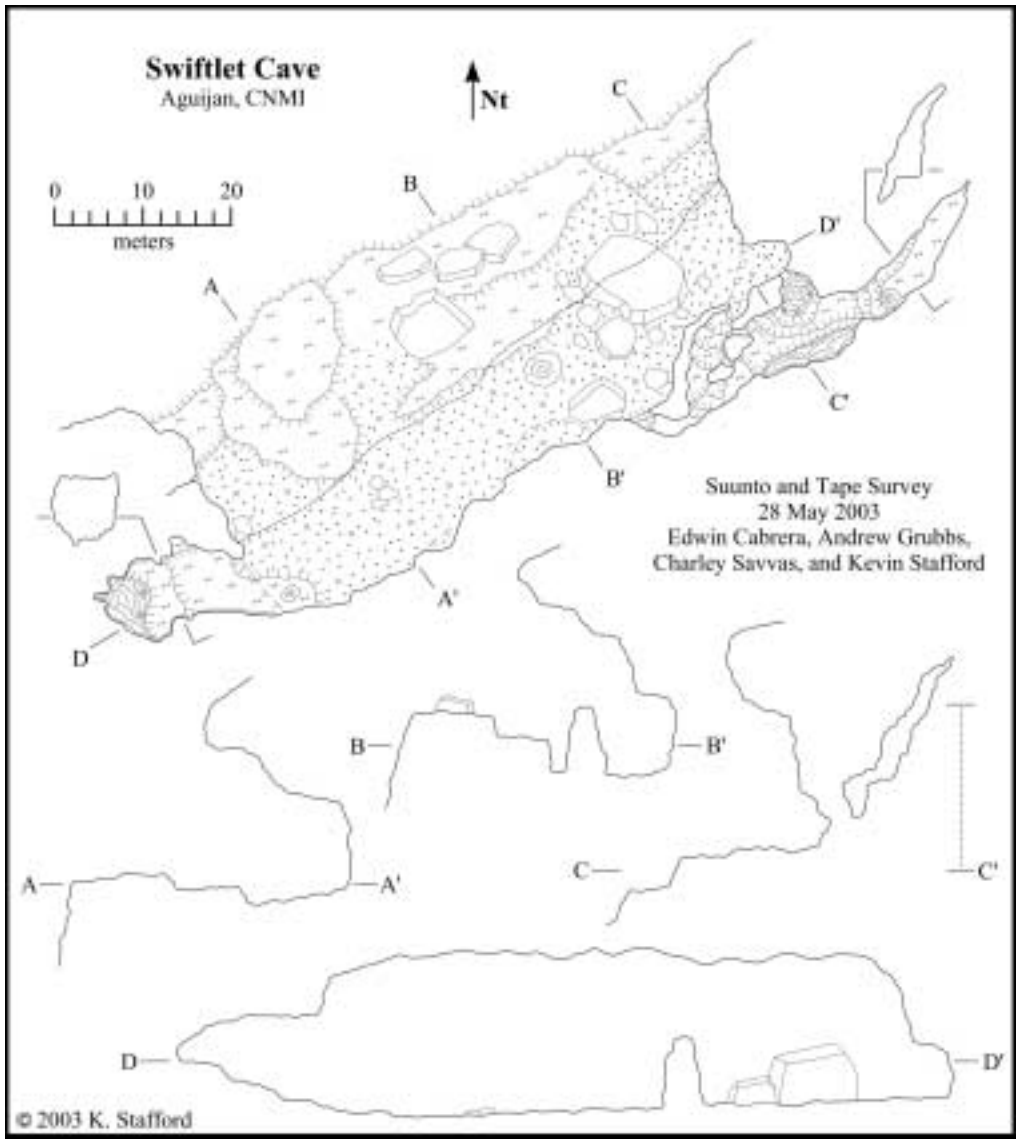

Figure 142: Map of Swiftlet Cave.

Swimming Hole Cave Complex (Median Valley, Tinian – Figure 143)

Swimming Hole Cave Complex is located 700 meters south of the historic Leprosarium site on the west coast. It consists of three flank margin cave remnants developed in the Mariana Limestone (QTmu). The northern cave in the complex forms a looped passage with two entrances; the larger, northern entrance is 10 meters wide and the smaller, southern entrance is 1.5 meters wide. The loop passage extends inland 8 meters with an average width of 2.5 meters and height of 1.5 meters. The middle cave in the complex also contains two entrances forming a looped passage, with the two entrances averaging 2 meters wide and extending inland 9 meters with and average width of 3 meters and height of 1.5 meters. The southwestern cave has a single 2-meter wide entrance and extends inland 12 meters, where it widens to 7 meters with a ceiling height of 1.5 meters. The caves in this complex have soil and detritus floors with some breakdown blocks located near the entrances. All three caves show evidence of human modification, primarily the leveling of floors.

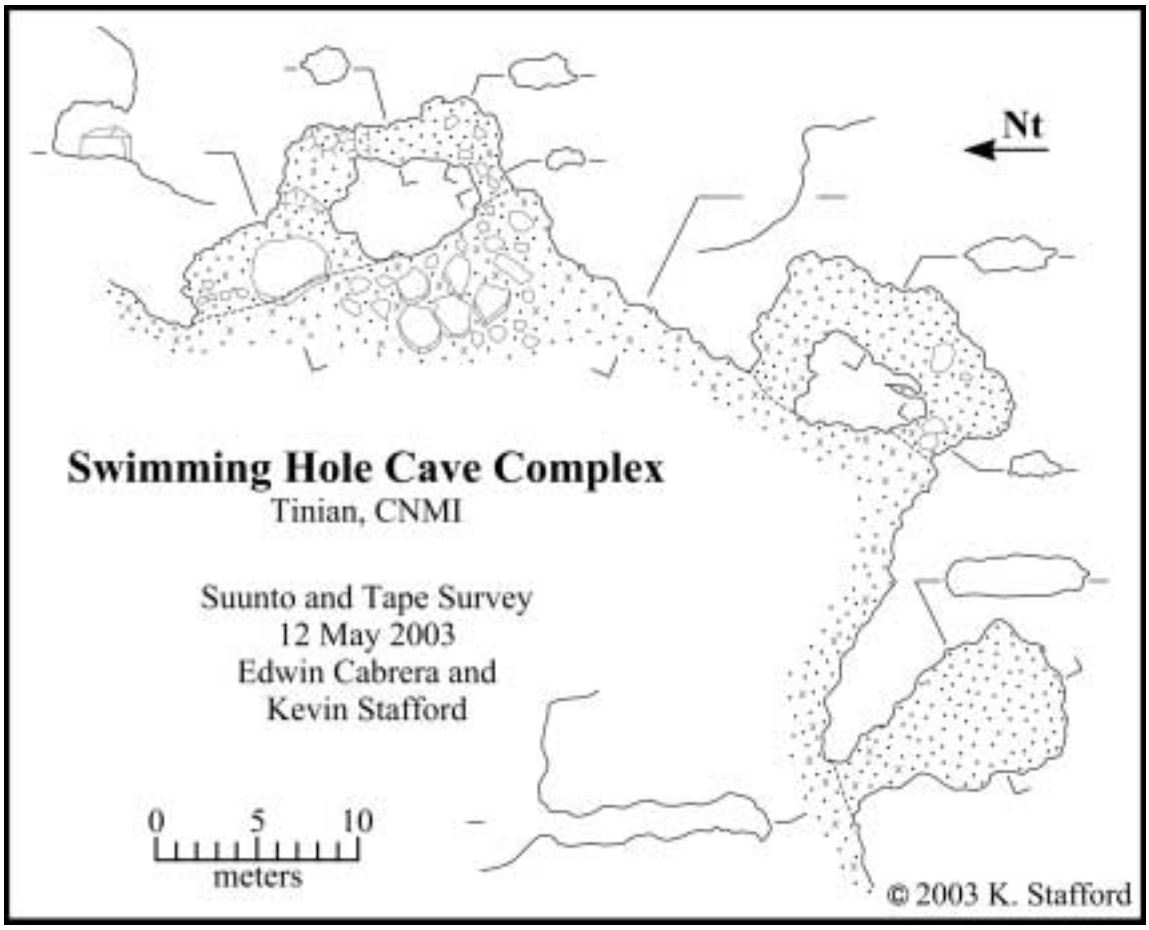

Figure 143: Map of Swimming Hole Cave Complex.

Toppled Column Cave (Middle Terrace, Aguijan – Figure 144)

Toppled Column Cave is formed along a fracture oriented at 5° in the southwest region of the Middle Terrace. It is developed in the Mariana Limestone (QTmu) and extends inland 23 meters with an average width of 2.5 meters. The feature is 8 meters tall in the entrance and decreases to 5 meters inland. The floor is composed of alluvium and large breakdown blocks in the entrance area and composed of bedrock in the inland part where the floor is elevated. The feature is similar to fracture-controlled, fresh-water discharge features seen at sea level on Tinian and is interpreted as a paleo-discharge feature. The cave is named for the large, broken stalagmite that is wedged in the passage near the entrance.

Tridactid Cave Complex (Middle Terrace, Aguijan – Figure 145)

Tridactid Cave Complex is located in the eastern region of the Middle Terrace in the Mariana Limestone (QTmu). It is composed of a series of flank margin caves that have been breached by scarp retreat. The features located in the southern part of the complex are shallow and extend inland less than 5 meters with and average height of 3 to 4 meters. In the northern part there is a larger flank margin remnant, which extends inland 35 meters and has bedrock columns dividing the entrance area. This larger remnant averages 1 to 2 meters tall and contains large amounts of breakdown in the middle of the chamber. The larger chamber is connected by a 2-meter deep ledge to a second passage that extends inland 20 meters with a ceiling height of 10

meters created by a floor drop of 8 meters. In the central region there is a split-level flank margin remnant, with a lower level that extends inland 8 meters and an upper level that extends inland 20 meters. The upper level contains two pits, which connected to small chambers that appear to have been partially excavated. In these excavated areas there are several well-worn, tridactid clam shells that appear to have been used for digging the poorly lithified bedrock walls and floor, thus giving the cave complex its name. Based on the proximity of the caves and their corresponding driplines, it is likely that most of these remnant flank margin caves where connected as one single cave in the past and have been separated by scarp retreat.

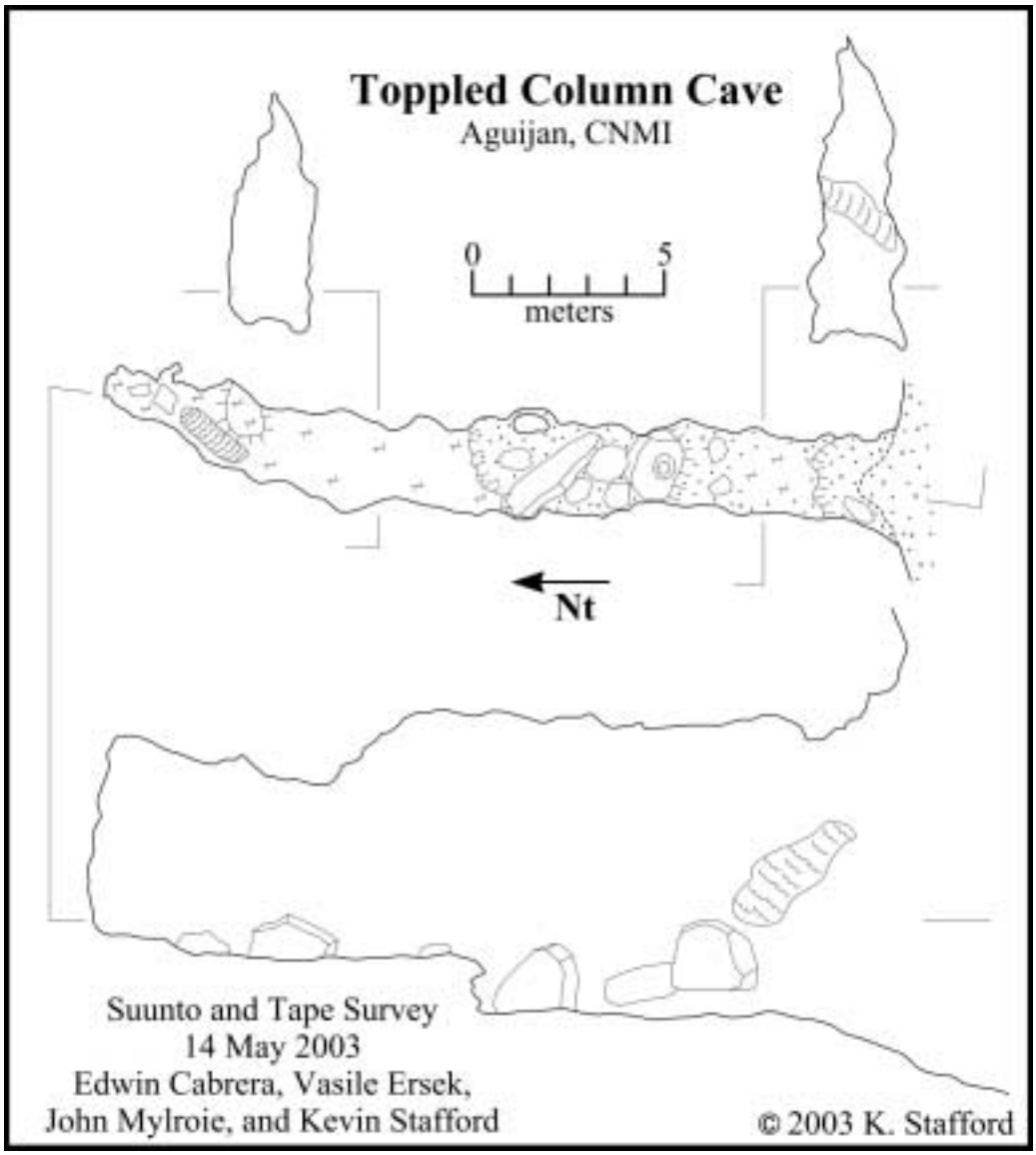

Figure 144: Map of Toppled Column Cave.

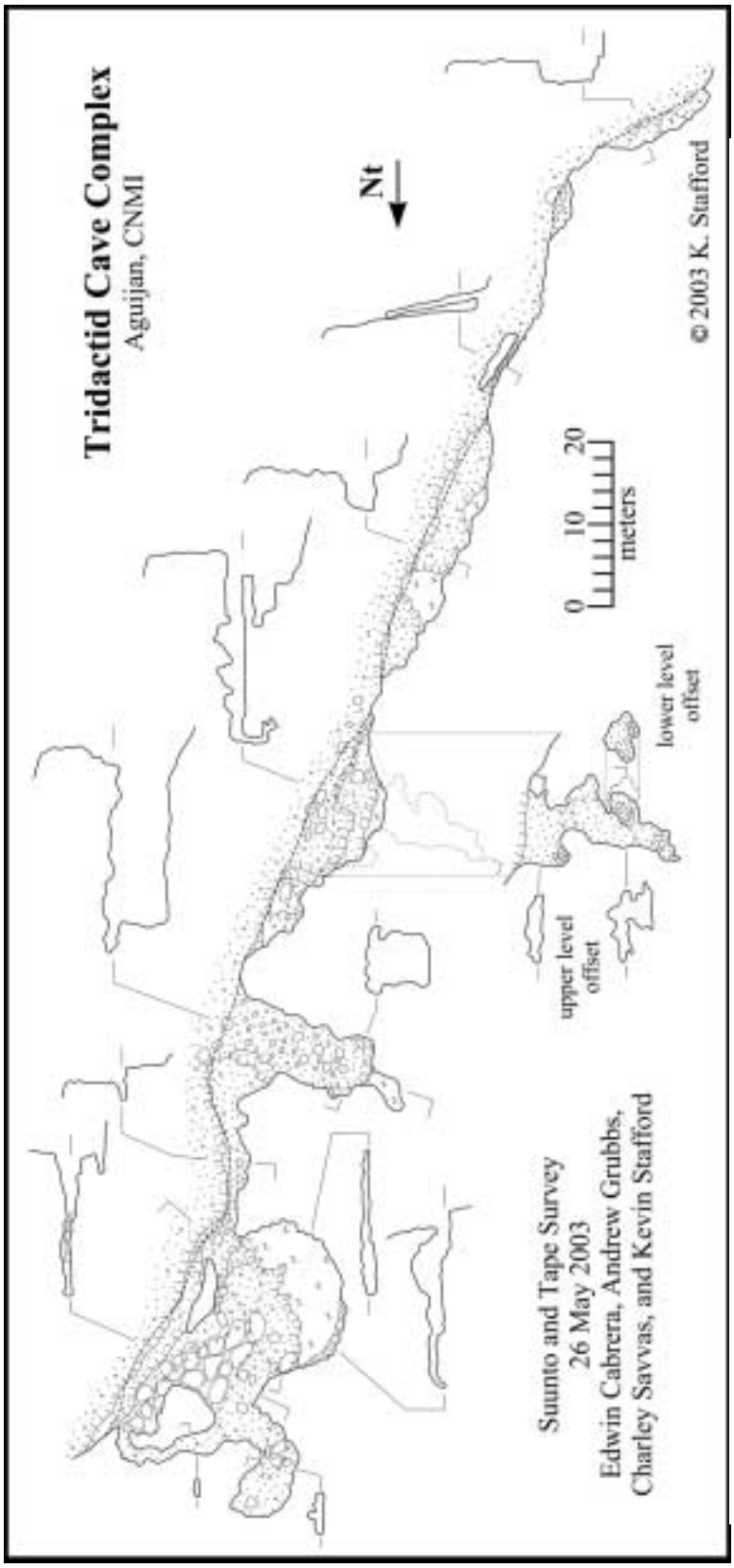

Figure 145: Map of Tridactid Cave Complex.

Twin Ascent Caves (Southeastern Ridge, Tinian – Figure 146)

These two caves are located in the central part of Suicide Cliffs, approximately 25 meters above the base of the cliff. They are the remnants of a breached flank margin cave developed in the Tagpochau Limestone (Tt) and are connected by a small, roofed ledge approximately 0.5 meters tall, indicating that the two features were joined as one cave prior to cliff retreat. The larger of the features is 11 meters by 15 meters with a maximum ceiling height of 9 meters, while the smaller feature is 8 meters by 10 meters with a similar ceiling height. In both caves, speleothems are present and in the larger feature minor excavation of the floor indicates that the feature was modified for use during WWII.

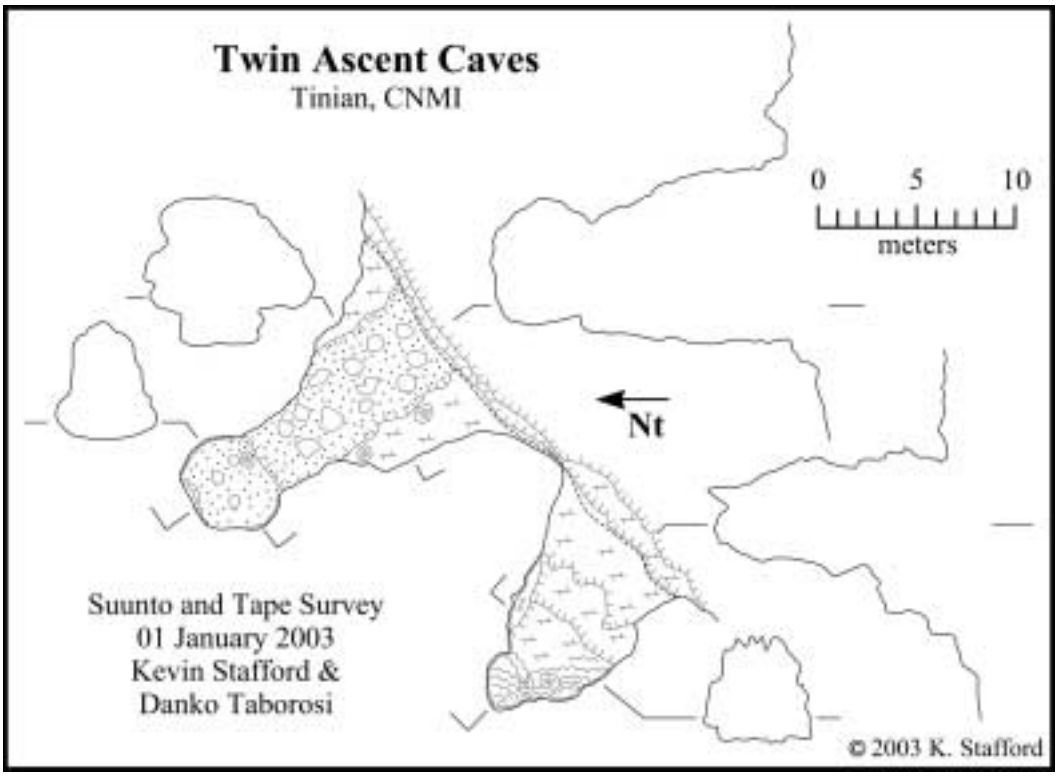

Figure 146: Map of Twin Ascent Caves.

Unai Chiget (Northern Lowland, Tinian – Figure 147)

Unai Chiget is located at the boundary between the Central Plateau and the Northern Lowland on the east coast of Tinian where the Northern Lowland has been down-dropped relative to the rest of the island along the Chiget fault, which trends 250^{o} in the Mariana Limestone (QTmca). The feature is a small embayment that has an average water depth between 0.5 and 1.5 meters and extends inland for 160 meters along the fault scarp, while cliff retreat and dissolution have widened the region to approximately 30 meters. At the seaward end of the feature, a series of large algal mounds are formed at the coastline, protecting the inland parts of the feature from more extensive wave erosion. The southern wall of the feature extends further inland and has a maximum height of 35 meters near the coastline, while the northern wall averages 4 meters and diminishes in height inland. Along the cliff walls, at sea level and up to 2 meters above sea level, is a well-developed, 1 to 2 meter deep, bioerosional notch. This feature shows extensive dissolution along the fault line and subaqueous grooves indicate that this feature may discharge fresh water, although no definitive evidence was seen.

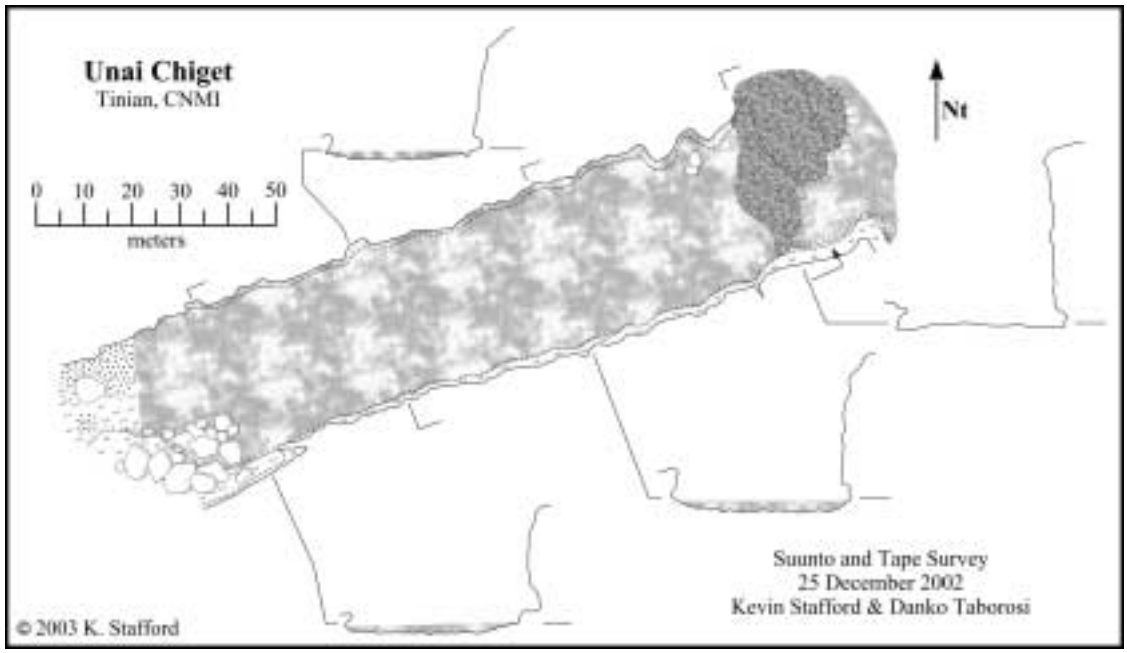

Figure 147: Map of Unai Chiget.

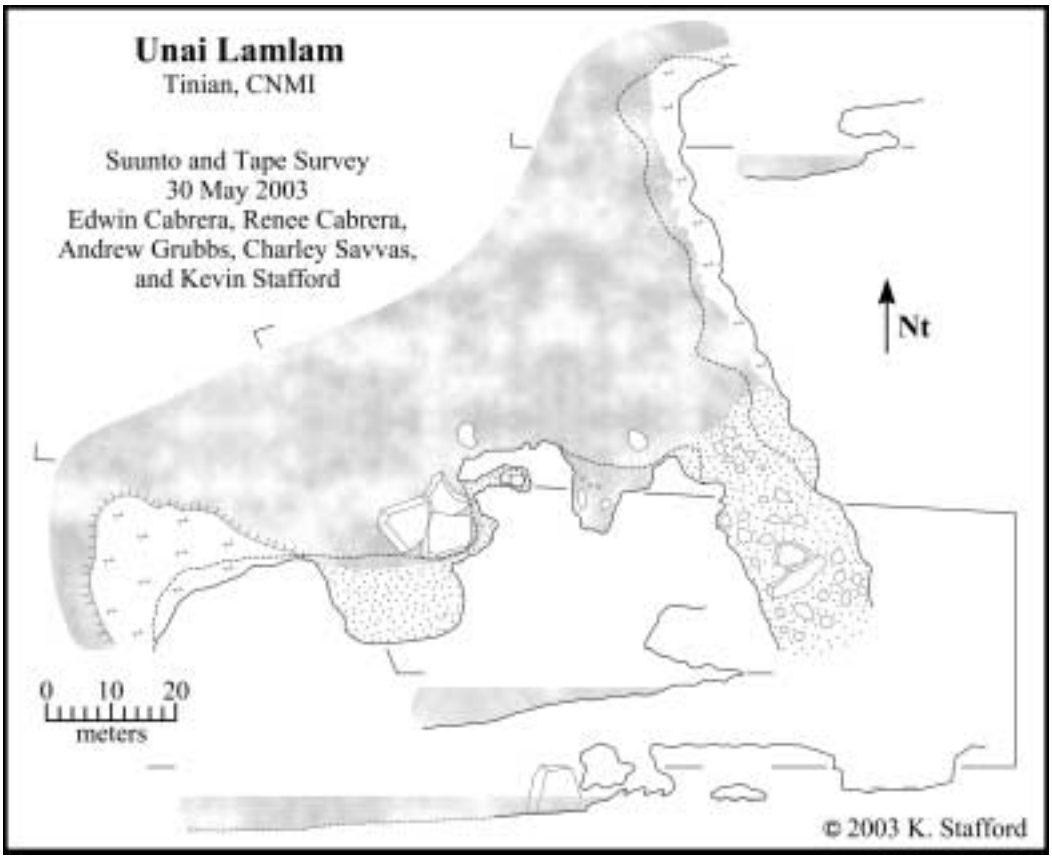

Figure 148: Map of Unai Lamlam.

Unai Lamlam (Northern Lowland, Tinian – Figure 148)

Unai Lamlam is a cove 110-meter wide, extending inland 90 meters in the Mariana Limestone (QTmcc) on the northwest coast. The main part of the cove is along the eastern edge of the feature and extends inland the greatest distance, where it narrows to 18 meters. The western portion of the cove contains two flank margin cave remnants that extend inland 15 meters from their ceiling drip lines, with average heights of 1.5 meters. The more protected interior regions of the cove contain carbonate sand beaches, while the more seaward regions have bedrock floors. In several areas, large breakdown blocks are presents, which appear to be remnants of collapsed ceilings.

Unai Masalok (Median Valley, Tinian – Figure 149)

Unai Masalok is a series of pocket beaches located on the east coast of the island and developed in the Mariana Limestone (QTmca). This series of four beaches is approximately 150 meters wide and extends inland for up to 50 meters. The individual beaches have several small remnant cave passages that extend inland from the cliff walls, remnant bedrock pillars, and speleothems. The overall morphology of the beaches and the presence of speleothems indicate that Unai Masalok was a series of flank margin caves that were breached by coastal processes and cliff retreat. Based on the available evidence, these features would have consisted of large flank margin cave chambers that were possibly connected where each of the individual pocket beaches are separated along the coastline. Throughout the feature there are numerous joints, which appear to be associated with cliff retreat. No evidence of offset could be discerned along these joints, but they appeared to trend roughly parallel to the coastline with variations in actual orientations throughout.

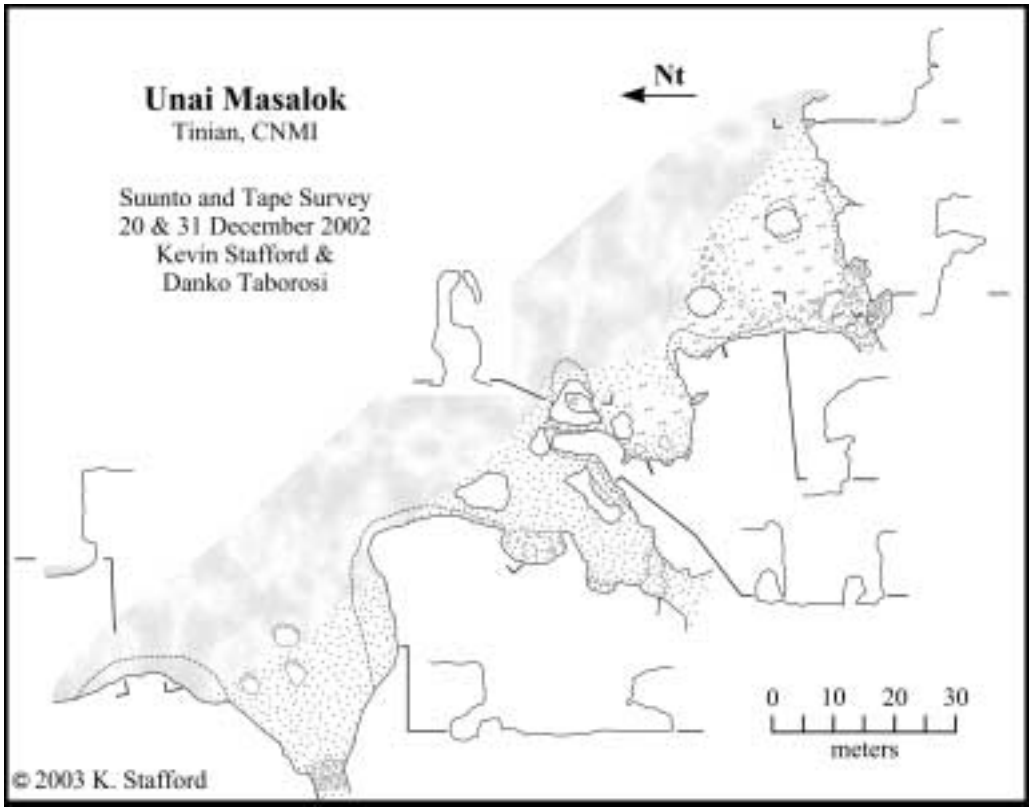

Figure 149: Map of Unai Masalok.

Water Cave (Median Valley, Tinian – Figure 150)

The Water Cave is located near Plunder Cave, approximately 2000 meters south of Taga Beach and 300 meters inland from the west coast. It is developed at the boundary between the Median Valley and the Southeastern Ridge provinces along a northeast/southwest trending fault that dips at approximately 35° to the southeast. This dissolutionally enlarged fracture cave is formed in the Mariana Limestone (QTmu) and is approximately 35 meters by 14 meters, descending to a depth of 13 meters where there is a 1-meter deep, linear pool of fresh water is encountered along the southern wall of the cave. The cave has extensive secondary deposits along in the central and northeastern parts, while the western parts are composed of much collapse material.

This feature shows evidence of extensive use by the Japanese military during World War II, probably because of the available water source in the bottom of the cave. There are anecdotal reports that the cave was sealed during the war on Tinian, which may explain the extensive breakdown and rubble in the western parts of the cave. However, the two entrances to the cave are small passages located in solid bedrock indicating that there was another entrance to this cave that is still blocked, if the reports are true.

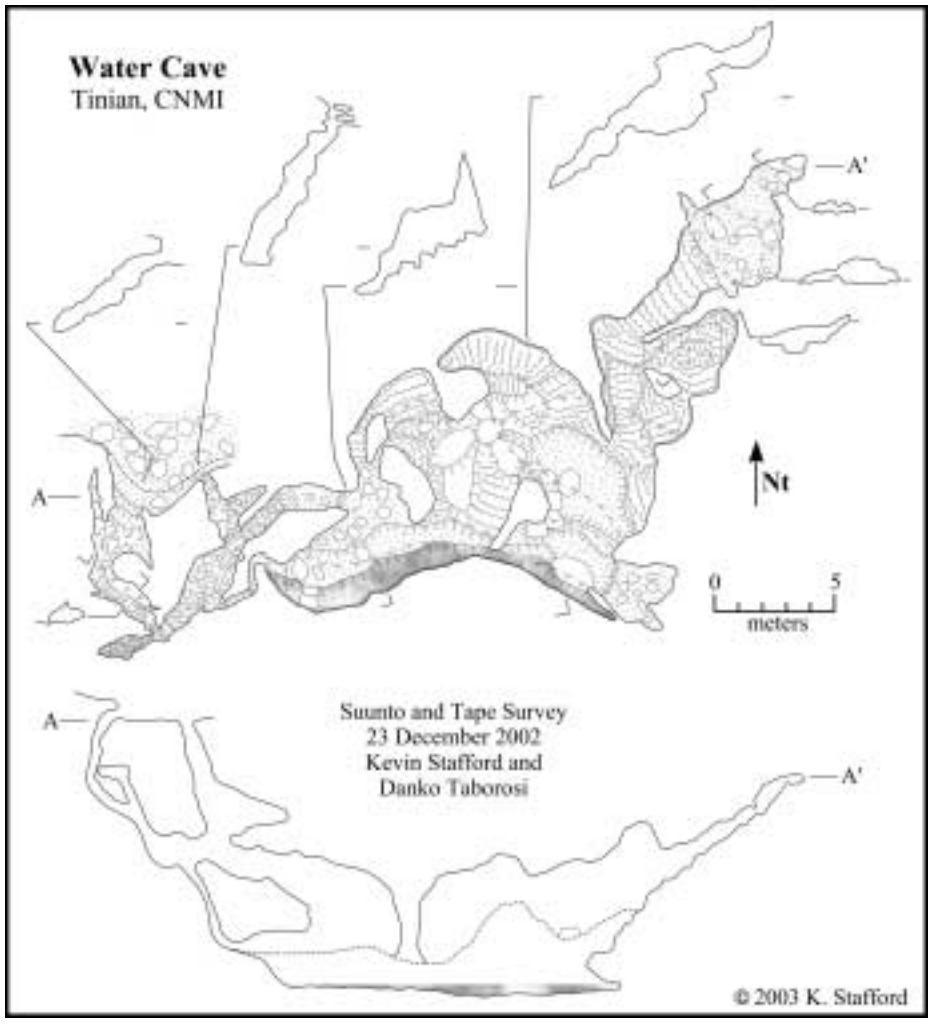

Figure 150: Map of Water Cave.

Waypoint Cave (Middle Terrace, Aguijan – Figure 151)

Waypoint Cave is a small, flank margin cave located in the eastern region of the Middle Terrace in the Mariana Limestone (QTmu). It consists of a small chamber, 5 meters wide and 1.5 meters tall, that has two scarp entrances on the east side and two small passages extending from the west side, with the entrances and passages roughly aligned. The floor consists of alluvium with minor breakdown blocks in the main chamber and a bedrock floor in the northern entrance passage.

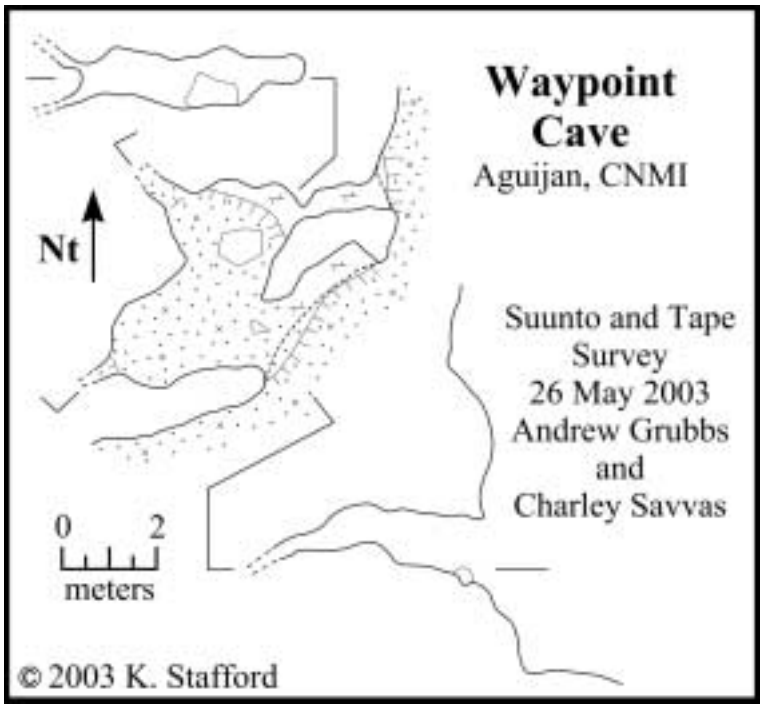

Figure 151: Map of Waypoint Cave.

West Lasu Depression Cave (Central Plateau, Tinian – Figure 152)

West Lasu Depression Cave is a closed depression recharge, located 1500 meters northwest of the peak of Mount Lasu in the Mariana Limestone (QTmu). The feature is approximately 25 meters in diameter and 4 meters deep, with the northern 5 meters of the feature covered by a 3-meter tall ceiling. The feature appears to be a significant recharge point with water being concentrated into the depression from the southwest edge. Lack of sediment coating the walls indicate that water does not pond here and enters the subsurface as diffuse flow, but that it acts as a fast flow route. This feature represents the most significant recharge feature that has be located northwest of Mount Lasu.

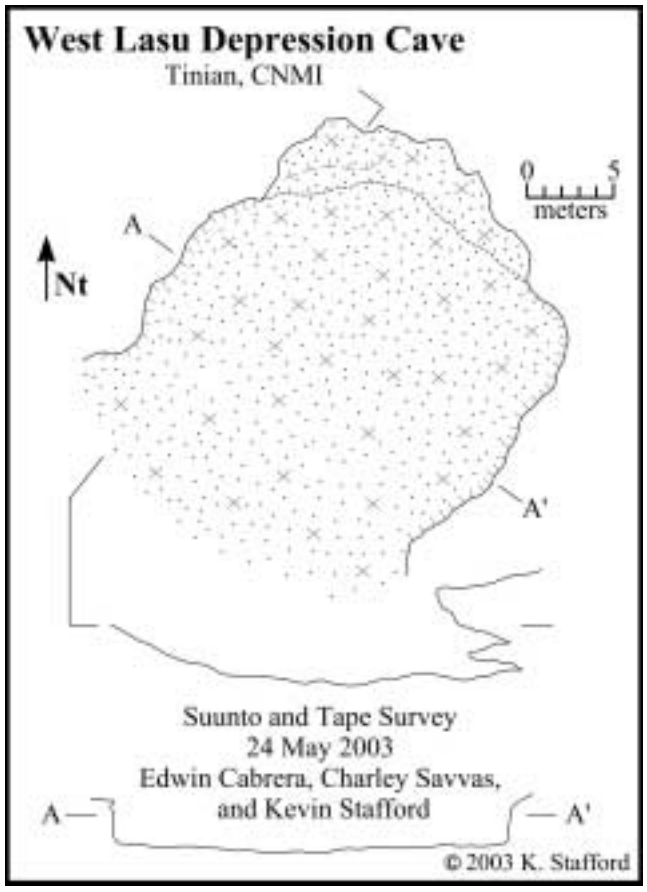

Figure 152: Map of West Lasu Depression.

West Suicide Cliff Caves (Southeastern Ridge, Tinian – Figure 153)

West Suicide Cliff Caves, developed in the Mariana Limestone (QTmu), are located at the west end of Suicide Cliffs near Carolina's Limestone Forest. This series of caves is located near the base of the cliff and represent a series of features breached by cliff retreat. The two caves on the southeastern portion of the series are approximately 18 meters by 6 meters each with ceiling heights ranging from 3 to 6 meters. They exhibit few speleothems and have extensive alluvium deposits on their floors. The largest, center cave, in this series is approximately 10 meters by 14 meters with a ceiling height of 6 meters. Associated with the center cave are two small cave remnants above the main chamber and a third small cave beneath it. West of the central cave are three small caves that do not extend inland a significant distance and a fourth larger remnant cave that is approximately 70 meters to the northwest of the central cave. The remnant cave that is the farthest to the west is approximately 8 meters by 10 meters with little ceiling remaining because of cliff retreat.

It is not possible to tell if these features were originally connected prior to cliff retreat, but it is thought that at least some of the features were joined in the past, because they are developed along a consistent horizon and are closely spaced, especially in the central and southeastern portions of this series.

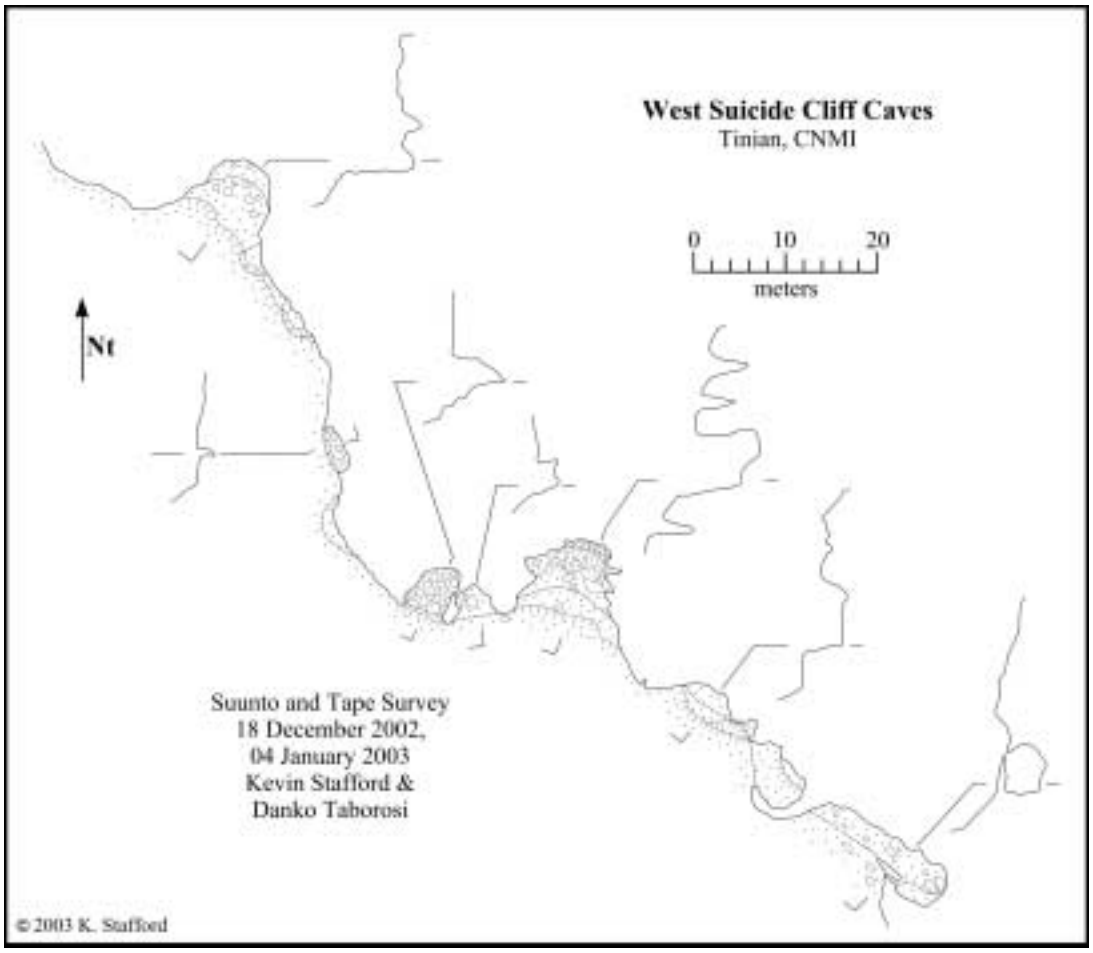

Figure 153: Map of West Suicide Cliff Cave Complex.