

MYTH-BUSTING: WAS PULAU TIGA REALLY FIRST CREATED BY A MUD VOLCANO
ERUPTION IN 1897?

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This manuscript has not been peer reviewed but has been submitted for review with the journal *INTERPRETATION*

ABSTRACT

No.

INTRODUCTION

Pulau Tiga is the largest mud volcano in Borneo and is located ~50km southwest of Kota Kinabalu in Sabah, Malaysia (5.73°N, 115.65°E; Figure 1; Figure 2). The island is comprised of three linked and approximately circular mounds of 60-75m height, from which Pulau Tiga ('Three Island') derives its name (Figure 2). Each of these three mounds is a mud volcano vent area, aligned approximately northwest-southeast, all of which have shown some degree of eruptive activity in the last 85 years (Musta and Sanudin, 1999; Figure 2). The most recent major eruption of the Pulau Tiga mud volcano occurred on the 19th February 1941 at the southeastern vent, and was so violent, and released such a large fireball, that the eruption was seen and heard over 50 kilometers away in what is now Kota Kinabalu (then Jesselton; Straits Budget 24th April 1941; Wilson, 1964). The northwestern vent displays a fresh tassik (dried mudflow) zone that indicates a minor eruption between January 2010 and November 2014 (Figure 2). The middle vent has no recorded recent major eruptive activity, but is constantly erupting small mud volumes and is presently used by tourists for mud volcano bathing (Figure 2).

A famous legend about Pulau Tiga is that it is a relatively new island, which only first appeared in 1897, concurrent with the 20th and 21st September 1897 earthquakes (Ms 7.4 and 7.5 respectively) that occurred offshore of Mindanao in the Philippines (epicenters ~6.0°N, 122.0°E). The legend of Pulau Tiga's sudden appearance, or 'birth', in 1897 is such a common and frequently repeated story that it is found in numerous scientific papers (e.g., McManus and

Tate, 1986; Morley et al., 2023), media stories (e.g., The Sydney Morning Herald 11th December 2011, BH Online 10th May 2015; Malaysia Post 2nd January 2021; The Star 19th September 2022; Free Malaysia Today, 12th January 2024), travel blogs (e.g., Malaysiasite “Pulau Tiga”) and both the English and Malay Wikipedia pages for Pulau Tiga (e.g. Wikipedia “Tiga Island, Malaysia”, 2023). A Google search for websites that must include both “Pulau Tiga” and “1897” yielded over 13000 hits, with ~90% of the top 500 websites in the search specifically claiming that Pulau Tiga was formed in 1897, and most describing a mud volcano eruption. However, despite its widespread prevalence, the origin of the story of Pulau Tiga’s 1897 ‘birth’ remains uncertain. The earliest description I can find of the reported 1897 birth of Pulau Tiga comes from McManus and Tate (1986), and states:

“It is reported that new islands formed at Pulau Tiga immediately north of Klias following an earthquake centered in Mandanau, Philippines on 21 September 1897 and felt across western Sabah but curiously not felt in the immediate vicinity of the islands. Violent eruption of mud and strong smelling gas accompanied the creation of a mud cone 20m in diameter and the gas burned for several weeks. Two years later, the island was 20m high and 240m across and was composed of loose accumulations of Tertiary sedimentary rocks. Eventually, three cones were formed to give three islands called, in Malay, Pulau Tiga.”

The detailed description in McManus and Tate (1986), and the widespread pervasiveness of the legend of Pulau Tiga’s rising from the sea in 1897, might, at first glance, suggest the story to be true. However, there are several lines of evidence that refute this account, and this study will present conclusive evidence that Pulau Tiga existed in something similar to its current form for centuries prior to its claimed birth in 1897, and will also determine the true details of mud

volcano activity in Sabah in September 1897. Following this introduction to Pulau Tiga and the legend of its formation in 1897, I will provide a brief review of mud volcanoes in Northern Borneo and a global summary of examples of mud volcano eruptions giving birth to new islands. I will then present evidence indicating that Pulau Tiga was not created in 1897 based on maps published prior to 1897, and present a review of studies and news reports that document the actual mud volcano activity in Sabah immediately following the 21 September 1897 earthquake. Finally, this study proposes a likely origin for the myth of Pulau Tiga's 1897 birth thorough analysis of past geological studies and reports of other mud volcano eruptions in Sabah.

MUD VOLCANOES OF NORTHERN BORNEO

Northern Borneo hosts over 20 confirmed mud volcanoes, with numerous more unconfirmed mud volcanoes reported in scientific studies (Figure 1; Fitch, 1959; Wilson, 1964; Wilford, 1967; McManus and Tate, 1986; Tongkul, 2017; Morley et al., 2023). These mud volcanoes can broadly be divided into two groups related to their geological location, namely the Sandakan Basin mud volcanoes in northeastern Borneo (e.g. Lipad, Binuang, Lahad Datu, Tomanggong and the Penyu/Turtle Islands mud volcanoes such as Pulau Bakkungan Kechil and Pulau Lihiman) and the Sabah Basin/Baram Delta Province mud volcanoes along the northwest Borneo coastal and offshore areas (Figure 1; Fitch, 1959; Musta et al., 2010; Tongkul, 2017; Morley et al., 2023). The Pulau Tiga mud volcano is the largest and best known mud volcano in the Sabah Basin/Baram Delta Province region. Other mud volcanoes located along the Northwest Borneo margin include the Bekenu/Ngebol, Kuala Nabor, Tanjung Lobang and Karap mud volcanoes of Sarawak, the Bukit Pantai and Muara mud volcanoes in Brunei, the Labuan mud

volcano on Labuan, and the Kampung Meritam and Kuala Penyu mud volcanoes of Sabah (Figure 1; Wilson, 1964; Sandal, 1996; McGiveron and Jong, 2016; Nazaruddin et al., 2016a; Nazaruddin et al., 2016b; Tongkul, 2017; Morley et al., 2023). The area also hosts several known submarine mud volcanoes, such as the Bestari mud volcano and the Pulau Batu Hairan mud volcano, and numerous mobile shale geological features exposed in outcrop in the Jerudong Anticline of Brunei and imaged on reflection seismic data offshore Brunei and Sabah (Figure 1; Tongkul, 1988; Lee, 1990; Sanudin et al., 1990; Morley et al., 1998; Van Rensbergen et al. 1999; Tingay et al.; 2003; McGiveron and Jong, 2016; Morley et al., 2023). All the mud volcanoes throughout the Sabah Basin/Baram Delta Province are driven by the high magnitude (often near-lithostatic) pore pressures generated by disequilibrium compaction in pro-delta shale sequences, with overpressures also often transferred into shallow sequences through vertical transfer overpressure mechanisms (Tingay et al., 2009). The mud volcanoes in the Sabah Basin and Baram Delta Province are primarily located along major structural features such as thrust faults, thrust-cored anticlines and inverted normal faults (Morley et al. 1998; Tongkul, 2017; Morley et al., 2023). The Pulau Tiga mud volcano is located above an inverted normal fault and mainly erupts fluids and sediments sourced from Setap Shale sequences (Musta and Sanudin, 1999; Morley et al., 2023).

MUD VOLCANOES AND THE ‘BIRTH’ OF NEW ISLANDS

The legend of Pulau Tiga being suddenly created from a large mud volcano eruption has precedence in many parts of the world, including offshore northern Borneo. Mud volcanoes generally display benign behavior, typically having only gentle to no mud eruptive activity, with

normal eruptive rates of most individual mud volcanoes around the world typically being 0-100 m³/day (Davies et al., 2007; Davies et al., 2011). However, mud volcanoes are also known to occasionally have extremely violent eruptions, also termed paroxysmal eruptions, that may erupt volumes 10⁴-10⁶ m³ of material over brief durations (typically minutes to hours; Davies et al., 2007). When these paroxysmal eruptions occur in a submarine mud volcano located in shallow waters, enough material can be erupted in a very brief period of time (minutes to hours) to push the mud volcano above the water's surface and create a new island. This has famously occurred offshore Pakistan several times, such as the formation of a new mud volcano island, Zalzal Koh, offshore Gwadar in 2013 (Bonini et al., 2016; Kassi et al., 2017). The low cohesion material erupted from mud volcanoes means that most such islands are quickly eroded away by wave action over just months or a few years, with Zalzal Koh disappearing after approximately three years (Voiland, 2019). These suddenly born and then disappearing mud volcano islands can even reappear at later dates when new paroxysmal eruptions occur, such as Malan Island off Pakistan appearing for brief periods in 1945, 1999, 2010 and 2013 (Kassi et al., 2017). Damaquiel mud volcano island appeared offshore Colombia on the 18th October 1992 after an earthquake and has reportedly appeared 15 times, most recently in June 2023 (Mosquera-Machado et al., 2009). Other suddenly appearing and then disappearing mud volcano islands are documented offshore of Azerbaijan (Kumani Bank; Alizadeh et al., 2016), Trinidad (Chatham Islands; Higgins and Saunders, 1967), Indonesia (in the Tanimbar and Kai Islands; Heim, 1942) and Malaysia (Pulau Batu Hairan; Tongkul, 1988; Lee, 1999; Sanudin et al., 1999), and are popularly referred to as 'ghost islands' or 'peek-a-boo islands'. Whether such a newly formed mud volcano island becomes permanent, or erodes away and slips again beneath the surface, depends on whether the overall rate of eruption exceeds the rate of erosion. If paroxysmal eruptions are large and

frequent enough to exceed the steady rate of material being eroded away by wave action, then the island will grow and become permanent. This is likely the origin of permanent mud volcano islands observed offshore Azerbaijan (e.g. Dashli Island that erupted violently on the 4th of July 2021 and Zənbil Adası that erupted in 1961 and 1995), Nantha Kyun offshore Myanmar, Pulau Kabawa in Indonesia, as well as the Penyu mud volcano islands and Pulau Tiga offshore Sabah.

APPEARANCE OF PULAU TIGA ON MAPS PRIOR TO 1897

It is highly likely that Pulau Tiga has formed primarily from mud volcano eruptions given that all three of its mounds are active mud volcano cones. Furthermore, it is known from its 1941 eruption that Pulau Tiga can have large paroxysmal eruptions, and that mud volcano eruptions have caused new islands to appear in many places, including off northern Borneo. Hence, it is possible that Pulau Tiga did suddenly appear as a new island (or islands) at some point in its geological history. However, the aim of this study is to specifically investigate whether Pulau Tiga appeared in September 1897, as is often claimed. One method for verifying this claim is to examine maps of northwest Borneo that were produced prior to 1897 to see if Pulau Tiga appears on them.

Several criteria were used in searching for evidence of Pulau Tiga on pre-1897 maps. The most important criteria was to identify whether maps explicitly labelled the island in approximately the correct location (with respect to nearby landmarks and the Borneo coast) using the name “Tiga”, or some similar variation (for example, “Tega”, “Teega”, “Tigan”, “Tigam”, “Tinga”). Particular care was taken to ensure that labels for Pulau Tiga were not being misidentified as other islands with similar names, most notably the major island now called

Labuan. Labuan is plotted on almost all old maps from northwest Borneo as it was a key navigational landmark for entering Brunei Bay, and the island itself was an important settlement after 1775 (Gerlich, 2012). Labuan is labelled as “Pulau Tigao”, “Pulau Tigaon” or similar on many maps from the 16th, 17th and 18th centuries (Gerlich, 2012). Indeed, two British maps from the 18th Century, produced by Blair in 1773 and Kitchin in 1787, refer to Labuan as “West Tigan” and Pulau Tiga as “East Tigan” (Gerlich, 2012). Care was also taken to ensure that Pulau Tiga off the Klias Peninsula was not being potentially confused with the other smaller Pulau Tiga located near Banggi Island off the northern end of Sabah (located at 7.34°N, 117.048°E) by ensuring the plotted or labelled island was in the approximate correct location in relation to other prominent plotted landmarks (e.g. Bandar Seri Begawan, formerly known as Brunei Town, and Mount Kinabalu, also formerly referred to as Mont de San Pedro or Mont Saint Pierre) and the northern Borneo coast. In addition to identifying maps that explicitly label Pulau Tiga, several additional maps that plotted an unlabeled island in the approximately correct location, and often with a shape similar to the Pulau Tiga’s shape today, were identified, but are considered herein to be less reliable as evidence of Pulau Tiga’s mapped existence prior to 1897.

The author found over 40 pre-1897 maps covering northwest Borneo where Pulau Tiga is charted, and with the island being clearly labelled by name on 36 of those, a sample of which is provided in Figure 3. Maps that explicitly label Pulau Tiga (or similar variants described previously) date back to the 16th century, and include charts by Lopo Homem (1554), Fernão Vaz Dourado (1576; Fig 3a) and Linschotten (Linschotten et al., 1598; Figure 3b). Pulau Tiga is also labelled on many famous 17th Century maps, such as ‘*Insularum Indiae Orientalis Nova Descripto*’ by Joan Janssonius and Hendric Hondius (1638), ‘*Tabula Indiae Orientalis*’ by F. De Wit (1662; Fig 3c), ‘*Archipelagus Orientalis, sive Asiaticus*’ by Joan Blaeu (1663; Fig 3d), ‘A

New Map of East India' by John Speed (1676), and 'Isole Dell'Indie, Divise in Filippine, Molucche E Della Sonda' by Vincenzo Maria Coronelli (1689). The author found Pulau Tiga plotted and labelled on 14 maps produced during the 1700s, such as Valentijn's (1726), 'Kaart van het eyland Borneo', Jean Baptiste Bourguignon D'Anville's (1751) 'Seconde Partie de la Carte d'Asie', and Bonne's (1771) 'Map of the East Indies' (Fig 3e). Numerous maps published throughout the 1800s also clearly identify Pulau Tiga, such as John Cary's 1801 'New Map of the East India Isles' (Figure 3f) and were often plotted very accurately, such as on British Admiralty Chart (2659) published in 1859 (Fig 3g) and Edward Stanford's 1888 "A Map of British North Borneo" (Fig 3h). Even Posewitz's "Geological Sketch Map of Borneo" (1889 and 1892), which was the first ever geological map covering Sabah, clearly labels "Tega I." as being located in Kimanis Bay off the northern end of the Klias Peninsular (Posewitz, 1889; Posewitz, 1892; see Wannier (2017) for an accurate reproduction of Posewitz's 1892 map). For an extensive compilation of old maps of Northwest Borneo, the author recommends Gerlich (2012), whose fascinating study reviewed maps of the area to determine the current name and location of the island of Mompracem. Mompracem is an island featured extensively in Emilio Salgari's famous 19th Century 'The Pirates of Malaysia' novels featuring the legendary Sabahan hero Sandokan (known as the 'Tiger of Malaysia', who fights against Dutch and British colonialists), and while the novels are fiction, an island called Mompracem was plotted on many old charts of northwest Borneo, before ceasing to be labelled on maps from ~1900.

Pulau Tiga is clearly identified on a wide range of maps spanning over 340 years prior to 1897 that were produced by cartographers from many countries and representing the observations of numerous different exploration and trade voyages (Figure 3). Hence, the evidence conclusively demonstrates that Pulau Tiga existed prior to 1897. Furthermore, the

consistent naming of Pulau Tiga for over three centuries also demonstrates that the island's three mud volcano cones, for which the island is named, also all existed before 1897. Finally, the shape of Pulau Tiga on many maps, and especially highly accurate maps from the 1800s, is essentially the same as the shape of Pulau Tiga today (Figure 3). Hence, this review of historical maps of northwest Borneo proves that Pulau Tiga was not 'born' in September 1897 and, in fact, existed with essentially the same shape for several hundred years prior to 1897. Thus, potential alternative explanations for the Pulau Tiga 1897 legend can also be dismissed, such as whether Pulau Tiga may have been a 'ghost' or 'peek-a-boo' island, like Pulau Batu Hairan, that had appeared and disappeared at times prior to 1897 before permanently re-appearing in 1897. Similarly, the potential hypothesis that just some part of Pulau Tiga was suddenly born in an 1897 eruption can also be dismissed, as all three mud volcano mounds were already charted on many maps and because the name of the island, used well before 1897, stems from those three mud volcano mounds.

NEWS AND SCIENTIFIC JOURNAL REPORTS OF MUD VOLCANO ISLANDS FOLLOWING THE SEPTEMBER 1897 MINDANAO EARTHQUAKES

The strong evidence from old maps demonstrating that Pulau Tiga did not suddenly appear in 1897 raises two key questions. Firstly, what impact, if any, did the September 1897 Mindanao earthquakes have on mud volcanoes in Sabah and, secondly, how did the legend of Pulau Tiga's birth in 1897 originate? Through a detailed search, I was able to find several newspaper articles and scientific reports that provide first-hand accounts of mud volcano activity and the sudden creation of islands offshore Sabah commencing immediately after the September

1897 Mindanao earthquake. These accounts, made by people who directly witnessed the mud volcano activity, are documented and summarized in this section and reveal the truth about the mud volcanoes and appearing islands in northern and northwest Borneo that were triggered by the 1897 Mindanao earthquake. In a subsequent section I will also propose a possible origin for the myth of Pulau Tiga's 1897 birth.

Eyewitness accounts from 1897 and 1899 document that not one, but two, new islands did suddenly appear offshore Sabah on the same day of, and are considered to be caused by, the 21st September 1897 Mindanao earthquake. An account of a new island forming following the earthquake was first described in a news article published in *The British North Borneo Herald* on the 16th of October 1897, where a Mr. Hewitt on Labuan provides a detailed description and approximate location, quoted in full below (*The British North Borneo Herald*, 1897).

“Mr. Hewitt writes from Labuan:— It may interest you to hear some details of the new island which has appeared on the Coast between Mempakol and Lumbidan. It made its appearance on Tuesday the 21st September about the same time that an earthquake was reported to have occurred in Kudat, (1-10p.m. in Sandakan. —En. Herald.)

The island, which is about 45 feet high, 250 yards long and 150 yards broad, is of very peculiar appearance. It is chiefly an upheaval of the sea bottom, but at the highest point it presents entirely different features. Here the surface of the sea bottom has been broken through from below and a mud crater formed, which has evidently been forcibly squeezed up through a circular hole in the bedrock further down. The mud crater presents the form of a cone with the top and side in places fallen in; the portions remaining intact show plainly, by the smooth striated sides, the effects of squeezing through the rock. The cone at its visible base is perhaps 20

yards in diameter and is surrounded at about 30 yards distance by a circular terrace a few feet high, which suggests that a little more pressure from below would have resulted in a far larger cone being thrown up. There is a lot of bubbling going on in various cracks and holes emitting a gas which flares up when a match is applied and continues to burn.

The island is well worth a visit at present but no doubt it will lose some of its peculiar appearance before long, as it is all very soft and will probably settle down somewhat, besides being affected by the present heavy rains.”

The description given by Mr. Hewitt clearly depicts the characteristics seen in other newly formed mud volcano islands following a paroxysmal eruption. Features such as raised seabed, a mud cone, flammable gas emissions, soft and muddy material, striated surfaces and surface cracking are all commonly seen in other new mud volcano islands, such as on Pulau Batu Hairan, Zalzala Koh and Malan Island (Tongkul, 1988, Lee, 1990, Kassi et al., 2017). The article also reports the location of the island as being “between Mempakol and Lumbidan”, “Lumbidan” is presently known as Kampong Lambidan, and is on the western coast in the southern Klias Peninsula (approximately 5.4°N, 115.38°E). “Mempakol” is currently called Kampung Mempakul, and is located at the tip of the southern Klias Peninsula near the town of Menumbok (approximately 5.3°N, 115.35°E). Thus, the article clearly describes the formation of a new mud volcano island triggered by the 21st September 1897 earthquake, but also states that the island was located off the west coast of the southern Klias Peninsula, and not at the location Pulau Tiga, which is off the northeastern tip of the Klias Peninsula (Figure 1).

A second ‘new island’ generated on the 21st September 1897 was reported by a Mr. R. M. Little and published in *The Geographical Journal* in 1898, which is quoted in full below (Little, 1898).

“New Island near Kudat, British North Borneo.—A short note by Mr. R. M. Little, describing a visit to a small island which rose from the sea during the earthquake of last year, appears in The British North Borneo Herald on January 1. The island, which is about 100 yards square, is situated about 4 miles south-east of Malundangan island, which lies to the east of the larger island of Banguéz. It rises 3 feet above high-water mark, and is covered with large boulders of hard sandstone, coloured, like the whole island, of a greyish white. The substratum is fire-clay traversed by cracks running from north-east to south-west. Coral of various kinds is strewn over the surface, and the boulders are covered with small oysters. Deep water is found to the north-east and west of the island, but to the south-east the sea is shallow. A shoal, partly visible at low water, had existed previously, according to native accounts. The emergence of the island is said to have been accompanied by the appearance of two waves, crossing the sea to the north, and by a rumbling noise, as well as a furious wind.”

This second new island, born coincident with the 21st September 1897 earthquake, is located off the northern tip of Borneo. The stated location of “approximately 4 miles south-east of Malundangan”, which is currently known as Pulau Balundangan (and the stated “larger island of Banguéz” is now called Banggi island), is approximately the same location as the Pulau Batu Hairan mud volcano (also known by local islanders as Batu Kiat, which means ‘Tip Stone’), that appeared most recently late on the 13th of April 1988, and is also reported by local elders to have appeared in 1914 and 1942 (Figure 1; Figure 4; *The Sunday Times* 15th May 1988; Tongkul,

1988, Lee, 1990; Sanudin et al., 1990). There are two Pulau Balundangan islands located next to each other, Pulau Balundangan Besar (Large Balundangan) and Pulau Balundangan Kecil (Small Balundangan). It is uncertain which of these two islands is referred to in Little (1898), though it is the author's opinion that the larger island is the more likely reference. The Pulau Batu Hairan mud volcano is located 4.1 miles southeast of Pulau Balundangan Besar and 4.2 miles to the east south-east of Pulau Balundangan Kecil. Hence, the "approximate" location of the 1897 island reported in Little (1898) is either almost exactly the same as (with respect to Pulau Balundangan Besar), or at most within 1.5 kilometers of (with respect to Pulau Balundangan Kecil), the location of Pulau Batu Hairan mud volcano.

The description of the island and the depths of its surrounding waters also match with the observations of Pulau Batu Hairan in 1988 (Figure 4; Tongkul, 1988; Lee, 1990; Sanudin et al., 1990). Whilst the evidence is not certain, the description and details given in Little (1898) strongly indicate that the Pulau Batu Hairan mud volcano also erupted due to the 21st September 1897 earthquake, causing the island to reappear for an unknown period of time. Local elder accounts of Pulau Batu Hairan, reported in *The Sunday Times* 15 May 1988, state that islands had also appeared and disappeared at or near that location in 1914 and 1942, and hence this account from 1897 likely represents a previously unknown earlier emergence of the island from over 125 years ago.

Professor Carl Schmidt of Basel University in Switzerland is regarded as one of, if not the first, professional geologists to visit and make detailed geological maps of Northwest Borneo during his time in the region in 1899 (Wannier, 2017). The results of his geological studies of the areas around Brunei, Labuan and the Klias Peninsula were published in 1904, along with

Schmidt's tectonic map and cross-sections through the area (Schmidt, 1904). In addition to regional and local descriptions of the geology, with a particular focus on coal and hydrocarbon deposits, Schmidt (1904) also devotes a section specifically on his visit to a "New Island" that he visited in 1899. A translation of the first key part of this section in Schmidt (1904) is quoted in full below (note: the translation from the original German text to English herein has been made by the author of this study and may potentially contain translation errors).

"II. The "New Island" created on September 21, 1897. I have already mentioned that exactly on the axis of that anticlinal, which runs parallel to the west coast of the southern part of Klias Peninsula, on September 21, 1897, a "New Island" near the coast. Its geographic position is 115°21' East longitude and 5° 20' 30" North latitude. During my visit on September 5, 1897¹, two years after the event, the following was found: an Island about 50m from the coast, about 20m high, about 150m long in an East-West direction and about 140m wide from North to South. Towards the West, i.e., against the surging, open sea, the same showed a steep drop of about 5 m high. The whole island consisted of loosely piled together material, coming from the Tertiary layers. On the surface of the island were blocks of coral limestone and oyster-studded sandstone. Approximately in the middle of the island rose a cone of hardened mud with a crater-like depression. The sheer drop towards the sea-side was constantly undermined by the impact of the waves and I don't know if there is anything left of the island today."

¹ The author of this study assumes that the stated year for Schmidt's visit of "September 5, 1897" in this particular sentence is a typographical mistake in Schmidt (1904). Firstly, the date 5th September 1897 is 16 days before this new island was even first observed. Secondly, Schmidt repeatedly refers to his visit to the area occurring in 1899, and also states in the same sentence that he visited the new island two years after its documented formation in September 1897. Hence, multiple other statements in Schmidt (1904) better agree with his visit to the new island occurring on the 5th September 1899, and not in the year 1897.

“Eyewitnesses have told me about the origin of the island and we can find some information about it in the literature. On the afternoon of September 21, gas bubbles rose with great violence from the shallow seabed; mud followed, mixed with boulders as they lay on the seabed. At first the seabed seems to have simply been arched up, then the softened layers of the Tertiary subsoil were pressed up from greater depths. A veritable mud crater measuring 20m in diameter formed on the highest part of the outcropping island. During the night of September 21-22, the island was still expanding. The seabed must have risen very quickly, because on September 22 live saltwater fish were found in the ponds on the new island. From the many fissures and holes gas emanated, which, when ignited, burned vigorously; a strong smell of gas made itself felt. Pressed between the rock debris was a soft waxy substance reminiscent of ozokerite, such as is also found in the oil-bearing layers of Labuan. Six months after the island surfaced, gas was still pouring from its bottom. It is remarkable that in the immediate vicinity of the island no shaking of the ground is said to have been noticed while it was growing. The original length of the island is given as 250m, so the waves had probably washed away 100m in a period of two years. While nothing is said to have been noticed on the Klias Peninsula itself of an earthquake accompanying the eruption, we received news of a large earthquake that originated on the Philippine island of Mindanao on September 21st and that was also registered in Europe. Since this earthquake was felt in Kudat in Northeast Borneo, as well as in Labuan, the creation of the “New Island” was immediately linked to it.”

Schmidt's (1904) description provides details of the only known visit by a professional geologist to this 'New Island', and confirms the previously quoted eyewitness reports made by Mr. Hewitt immediately after its formation in 1897 (The British North Borneo Herald, 1897). In particular, Schmidt (1904) clearly documents that this new island formed off the western coast of

the Klias Peninsula, at a location approximately 53 kilometers from Pulau Tiga. However, it should also be noted that there are some discrepancies in the exact location of this 'New Island' given in Schmidt (1904). Schmidt (1904) provides latitude and longitude coordinates for the island that yield a location approximately 1500m offshore of the Klias Peninsula, whereas both Schmidt's own description and the 1897 description by Mr. Hewitt is that the island is located just 50m offshore (Figure 1; Figure 5; The British North Borneo Herald, 1897). Schmidt's (1904) published tectonic map and cross-sections also mark the new island as being located very close to the Klias Peninsula, and specifically right off of what is now called Bukit Tomboh, a small rocky promontory located at 5°20'47"N, 115°21'46"E approximately halfway between Kampong Lambidan and Kampung Mempakul (Figure 5). So, while all reports place this new 1897 island as being located off the western coast of the Klias Peninsula, the majority of evidence indicates that the island was, more specifically, located just ~50m off of Bukit Tomboh, though no clear evidence of this island is seen today in satellite imagery (Figure 5). Regardless of the precise location, it is clear from all accounts that the new island that formed on the 21st September 1897 offshore of the Klias Peninsula was not Pulau Tiga, but rather a different island in the area of Bukit Tomboh, but which has long since eroded away and slipped beneath the waves.

Schmidt (1904) specifically identifies this new island as being a mud volcano. The term 'mud volcano' is not used by earlier descriptions of this new island by non-geologists, nor for the other island that appeared near Pulau Batu Hairan mud volcano (The British North Borneo Herald, 1897; Little, 1898). Schmidt (1904) includes evidence that supports his interpretation of the island's creation being due to a mud volcano eruption. He describes how mud volcano eruptions have sometimes been linked to distant earthquakes, citing many examples from Azerbaijan, Myanmar, Timor, Sicily and Crimea. Schmidt (1904) also cites the sudden formation

of a new island at Kumani Bank offshore Azerbaijan as an example of mud volcano eruptions being able to create new islands. Finally, Schmidt (1904) highlights the proximity of the new island to known mud volcanoes on the Klias Peninsula and also cites the study by Little (1898) to note the appearance of a second island offshore Sabah on the 21st September 1897 and to propose that the second new island, off northern Borneo, was also created by a mud volcano eruption.

In summary, there are multiple eyewitness accounts in both newspapers and scientific journals published between 1897 and 1904 that document the sudden ‘birth’ of two new islands offshore Sabah on the 21st of September 1897. Neither of these islands is at, or anywhere near, the location of Pulau Tiga. Indeed, there is no documented record of Pulau Tiga erupting at all in 1897 (though an undocumented eruption cannot be ruled out). One island was located approximately 50m offshore of Bukit Tomboh ($5^{\circ}20'47''\text{N}$, $115^{\circ}21'46''\text{E}$), and was interpreted by Schmidt (1904) to be the result of a mud volcano eruption (Figure 1; Figure 4). This island was last definitively observed in September 1899, by Professor Carl Schmidt, but has since disappeared (likely in the first few years of the 1900s, based on Schmidt’s observed erosion rates). The author has not found any convincing evidence of this island ever appearing again. The second new island that formed immediately after the 21st September 1897 earthquake is located off the northern tip of Sabah, and position descriptions match closely with the location of Pulau Batu Hairan ($7^{\circ}17'46''\text{N}$, $117^{\circ}22'49''\text{E}$; Figure 1). Pulau Batu Hairan is a documented ‘peek-a-boo’ or ‘ghost’ mud volcano island that most recently suddenly re-appeared in 1988 before disappearing in 1990, and reportedly also appeared in 1914 and 1942 (Figure 4; The Sunday Times 15 May 1988; Sanudin et al., 1990). Hence, this second mud volcano island that

formed in 1897 is interpreted to be a previously undocumented or unrecognized eruption and emergence of the Pulau Batu Hairan mud volcano.

PROPOSED ORIGIN FOR PULAU TIGA'S 1897 BIRTH MYTH

The evidence from pre-1897 maps, combined with the documented eyewitness reports, conclusively demonstrate that Pulau Tiga did not suddenly appear in 1897, but rather that two entirely different new islands appeared off Sabah due to mud volcano eruptions triggered by the 21st September 1897 Mindanao earthquake. However, the question remains as to how the myth of Pulau Tiga being 'born' in 1897 originated. In this section, I propose that the most likely origin for this myth is from McManus and Tate (1986), who I propose have conflated old descriptions of the mud volcano island formation off Bukit Tomboh with an eruption of Pulau Tiga.

The description of Pulau Tiga being born in 1897, as described in McManus and Tate (1986), and quoted previously in my introduction, is the earliest example I can find of this myth following an extensive review of the literature. Mud volcanism in Sabah is documented in some detail in several earlier studies that the author was (recently) able to obtain, namely Fitch (1959), Wilson (1964) and Wilford (1967), with the Wilson (1964) study being explicitly cited by McManus and Tate (1986) in reference to Pulau Tiga. However, none of these studies makes any mention of an eruption of Pulau Tiga in 1897. Indeed, Wilson (1964) directly quotes from Schmidt (1904) to describe the emergence of the new mud volcano island off of Bukit Tomboh, and both Fitch (1959) and Wilson (1964) mention the appearance of the new mud volcano island

off of northern Sabah, and which is interpreted herein as a prior appearance of Pulau Batu Hairan. Wilford (1967) mentions the appearance of these two islands, citing and directly quoting from Wilson (1964).

Pulau Tiga is mentioned as a mud volcano in both Wilson (1964) and Wilford (1967). Wilson (1964) describes the major eruption of Pulau Tiga's southeastern vent in 1941, and noted that this same southeastern vent was having a moderate eruption when the British Borneo Geological Survey visited the mud volcano in 1961. Wilford (1967) mentions a large and long running eruption on Pulau Tiga occurring in "February 1949", although it is likely that this stated year is incorrect, as the brief description of the eruption in Wilford (1967) closely resembles descriptions of the violent Pulau Tiga eruption on the 19th February 1941. Wilson (1964) and Wilford (1967) also mention a major and violent mud volcano eruption in September 1939 near Tanjong Nosong (the northern tip of the Klias Peninsula), and almost certainly what is currently known as the Kuala Penyu mud volcano (Figure 1), as well as the occurrence of small mud volcanoes throughout the Klias Peninsula and elsewhere in northern Borneo. Wilson (1964) even mention the brief emergence of yet another 'peek-a-boo' mud volcano island, this time occurring in 1935 at Nosong Shoals (approximately 15km west of Pulau Tiga).

The eruption of Pulau Tiga on the 19th of February 1941 is likely the largest mud volcano eruption ever witnessed in Malaysia. The following is the complete text of a 24th April 1941 article in the Straits Budget describing violence of the 19th February 1941 paroxysmal eruption of the Pulau Tiga mud volcano, which is provided herein to document this major event in the recent geological history of Sabah (Figure 6).

“Island Off Borneo “Explodes” – One night recently residents in British North Borneo had an alarming experience. A terrific explosion was heard and the sky was lit up for miles around. Europeans and Asiatics were puzzled until someone with long experience in Borneo suggested that the explosion was caused by an eruption on a small island off Jesselton. He was right.

An eruption had occurred at the top of a hill on Pulau Tiga, some 60 miles from Jesselton and the force of the explosion was such as to completely flatten some 75 acres of growing jungle. The jungle was flattened by the explosion and subsequently buried to a depth of 15 to 20 feet with heavy black volcanic earth which belched forth from the point of eruption.

A subsequent examination by Mr T.J.H. Speedy, Land and Survey Department; showed that there was no crater, the place from which the earth and flames had come having filled itself in the process of erupting. An area of about 20 square yards at the top of the hill was covered with a friable yellow earth from which flames were issuing to a height of five or six feet several days after the eruption occurred. These flames were caused by gas, which smelt very much like coal gas.

The flow of earth had covered an area of about half a square mile and reached the beach on one side while the trees on the other side were stripped of all foliage and were burnt in places, some still showed signs of damage caused by flying timber.

Pulau Tiga is about 1700 acres and is uninhabited and situated on the direct steamship route between Singapore-Labuan-North Borneo.

Where a few weeks ago there were 75 acres of healthy growing jungle there now is 75 acres of burnt slate coloured brittle mud, split into myriads of irregular shaped cracks, varying from two to eight feet deep, one to three feet wide and four to 100 feet in length.

The crest of the hillock from whence the main vent of gas had escaped appeared, nine days after the eruption, burnt to a red brick colour for an area of about 5000 square feet, and gas flames to about two-and-a-half feet in height still flickered.

The eruption would probably technically be called a mud volcano. A very similar occurrence took place on Tanjong Nosong to the eastward of Pulau Tiga in 1939.”

All the reports and scientific studies from 1897 to 1967 that were obtained by the author clearly document that Pulau Tiga is an active mud volcano that erupted violently in February 1941, but also demonstrate that it was other mud volcano islands, and definitely not Pulau Tiga, that suddenly emerged from the seas in September 1897. Furthermore, none of these documented accounts agrees with the claim by McManus and Tate (1986) that Pulau Tiga first appeared in 1897 (see quoted extract in the introduction above). However, it can be noted that the detailed description given in McManus and Tate (1986) has many similarities to the reports by Schmidt (1904) of the 'New Island' off of Bukit Tomboh. Both Schmidt (1904) and McManus and Tate (1986) describe how the Mindanao earthquakes were felt across western Sabah but not in the immediate vicinity of the island. Both studies also describe an eruption of gas from a 20m wide crater. Most tellingly, McManus and Tate (1986) state “Two years later, the island was 20m high and 240m across”, which is the same dimensions and the same time after the earthquake as Schmidt's visit to the 'New Island' in 1899. Hence, it is the conclusion of this author that

McManus and Tate (1986) have wrongly attributed the emergence of a mud volcano island off Bukit Tomboh as being the initial emergence of Pulau Tiga.

How McManus and Tate (1986) conflated the 1897 eruption offshore of Bukit Tomboh with Pulau Tiga is uncertain, and I can only speculate herein. It is possible that they obtained this false information from another published study, but no prior study has been found so far that proposes an 1897 ‘birth’ of Pulau Tiga. Furthermore, the only study cited by McManus and Tate (1986) in relation to their reported emergence of Pulau Tiga is Wilson (1964). As described above, Wilson (1964) does not ever claim that Pulau Tiga emerged, nor even erupted, in 1897 and only accurately quotes Schmidt (1904) on the emergence of the ‘New Island’ offshore of the Klias Peninsula. However, Wilson (1964) does postulate that Pulau Tiga was built up from repeated mud volcano eruptions immediately before describing the emergence in 1897 and 1935 of new mud volcano islands off the Klias Peninsula. Furthermore, Wilson (1964) does not provide a detailed location of where the 1897 mud volcano island occurred, simply describing it as being offshore of the Klias Peninsula “in the sea off Lambidan”. It is possible that McManus and Tate did not know, or were unable to determine, the location of the small village of Lambidan, and so instead simply considered the 1897 island emergence to be somewhere off of the Klias Peninsula, off of which Pulau Tiga is also located. It is also possible that the widely documented large and violent eruption of Pulau Tiga in 1941 made McManus and Tate wrongly believe Pulau Tiga to be the most likely, or even only, candidate for the reported 1897 emergence of a new island off the Klias Peninsula (not being aware that the actual island that appeared in 1897 had long since disappeared). Hence, whilst this remains speculative, I propose that the original source of the ‘1897 Pulau Tiga emergence myth’ is the study by McManus and

Tate (1986), who appear to have wrongly attributed Wilson's (1964) summary of a new island appearing off the Klias peninsula in 1897 to being the emergence of Pulau Tiga.

CONCLUSIONS

A detailed review of historical maps and charts dating from 1554 to 1892 demonstrate that Pulau Tiga existed, and in near to its current form, for several centuries prior to 1897. Hence, it can be concluded that the widespread reports in scientific papers, news articles and internet sites of Pulau Tiga being suddenly and spectacularly 'born' in 1897 are a frequently repeated false myth. The most likely source of this myth is the 1986 study by McManus and Tate, and it is proposed that they mistakenly confused an account in Wilson (1964) of a new island forming off the Klias Peninsula in 1897 with an eruption of Pulau Tiga. Whilst it remains unknown whether Pulau Tiga even experienced an eruption in 1897 (there are no documented accounts), eyewitness reports presented herein from newspaper articles and scientific publications reveal that two new islands did suddenly appear offshore Borneo on the 21st September 1897. One new island was located just offshore of what is currently called Bukit Tomboh, on the western Klias Peninsula and has been named herein as the Bukit Tomboh mud volcano. The other new island that appeared is interpreted herein to be an earlier, and previously undocumented, emergence of the Pulau Batu Hairan mud volcano that last emerged off the northern tip of Sabah in 1988.

Malaysia is one of the few countries in the world that hosts a large number of active mud volcanoes, with over 20 confirmed onshore mud volcanoes in Sabah, Sarawak and Labuan. Yet, there has been relatively little published on Malaysian mud volcanoes in the last 40 years and, as presented herein, there are several instances of incorrect or conflicting information published on Malaysian mud volcanoes, such as the myth of Pulau Tiga's 1897 birth. Furthermore, the review of available literature from 1897 to 1967 conducted herein has revealed that there is a wealth of information on Malaysian mud volcanoes that appears to have been essentially forgotten by the geoscience community. Findings from this study not only revealed the location of the forgotten Bukit Tomboh mud volcano island and a previously undocumented emergence of Pulau Batu Hairan, but also unearthed reports that another mud volcano island also appeared at Nosong Shoals in 1935. In addition, the past studies indicate the potential existence of many additional onshore mud volcanoes that appear to be 'lost' to modern geologists, or that have only recently been 're-discovered' (such as the Labuan mud volcano; Nazaruddin, 2016b). Finally, the detailed account herein of the 1941 Pulau Tiga eruption, the largest documented mud volcano eruption in Malaysian history, as well as the mentioned eruption near Nosong Point (Likely the Kuala Penyu mud volcano) in 1939, should be a reminder that Malaysian mud volcanoes are geohazards that represent a potential danger. Whilst rare, mud volcano eruptions have caused deaths and injuries in some parts of the world, and subsurface eruptions may be a threat to submarine infrastructure. The 18th of September 2022 eruption of the Lipad mud volcano in Sabah occurred with no warning and was closely witnessed by several people who were fortunately far enough away to avoid injury (The Star, 19th September 2022). The 1939 Nosong Point (likely Kuala Penyu) and 1941 Pulau Tiga mud volcano eruptions were far more violent, and fortunately occurred at a time when there were no people living nearby. However, people do now live or stay near those mud

volcanoes, and a repeat of those eruptions today has a much greater potential to cause injury or damage. Hence, while this paper primarily ‘myth-busts’ the story of Pulau Tiga’s 1897 birth, this study also highlights that Malaysia’s mud volcanoes have a far richer and more spectacular history of eruptions than has been recognized by the current geological community, and that these remarkable geological features deserve our recognition, study and respect.

ACKNOWLEDGMENTS

The author wishes to thank Ahmad Fairus Ahmad Zamri and Mazlan B. Hj. Madon for their strong encouragement to undertake this study. The author also wishes to thank Professor Felix Tongkul for providing some of the studies and photographs on Pulau Batu Hairan referenced herein.

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FIGURES

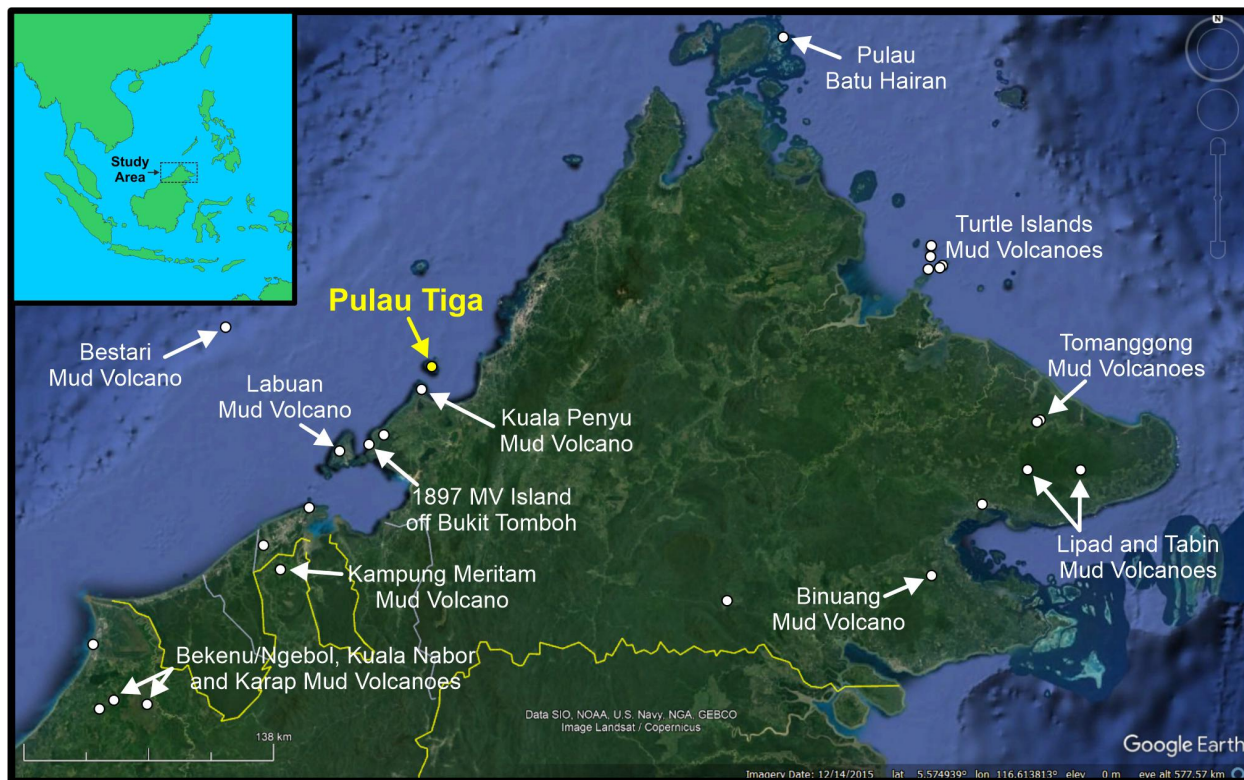


Figure 1: Location of the Pulau Tiga mud volcano and other major confirmed mud volcanoes in northern Borneo.

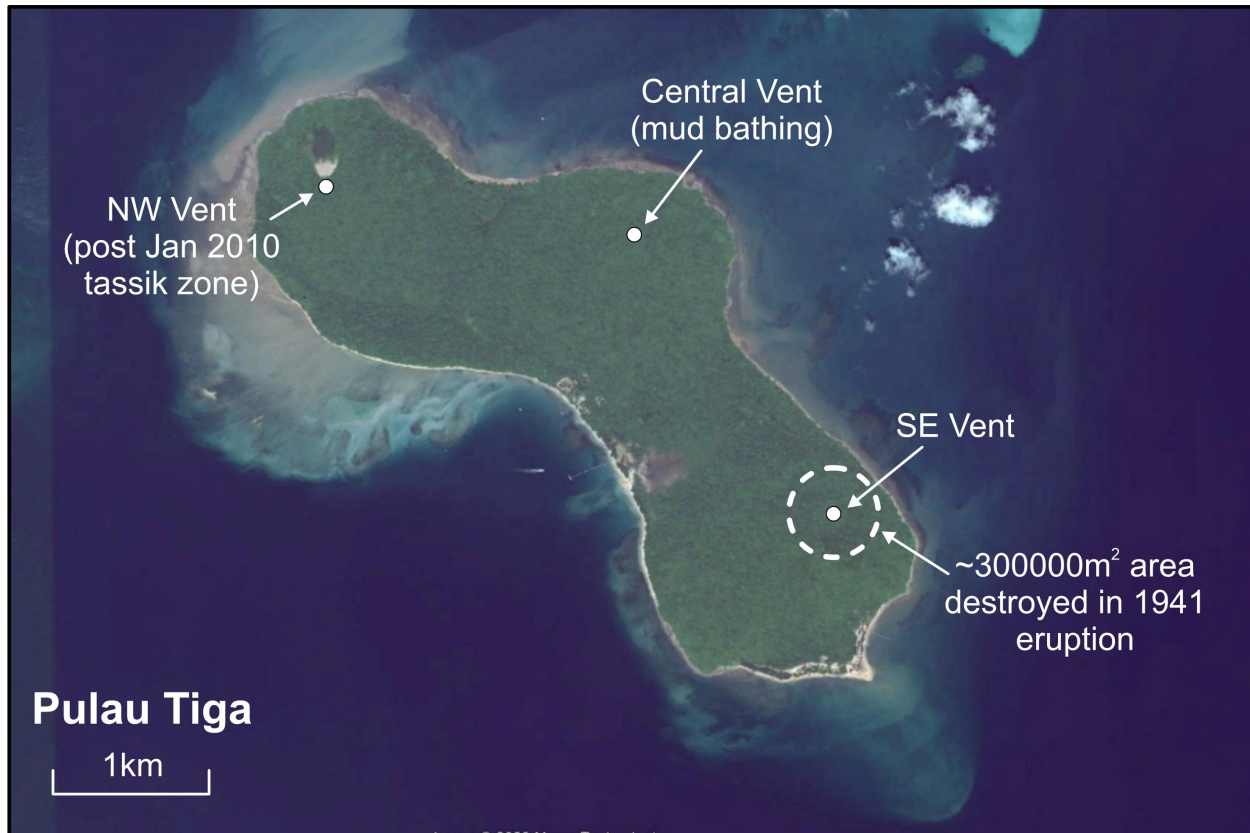


Figure 2: Pulau Tiga contains three active mud volcano vents that are in the approximate center of each of the three connected conical hills that give the island its name ('Three Island'). The Southeast Vent is the location of the violent February 1941 eruption that destroyed ~300000m² of forest and released a fireball and loud bangs seen and heard over 50km away. The Northwest Vent displays a recent tassik (mud flow) zone indicating a minor eruption occurring between January 2010 and November 2014. The central vent is constantly weakly active and is used for mud volcano bathing and tourism.

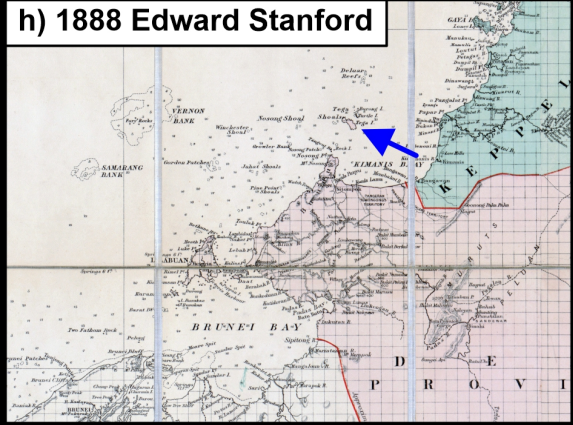
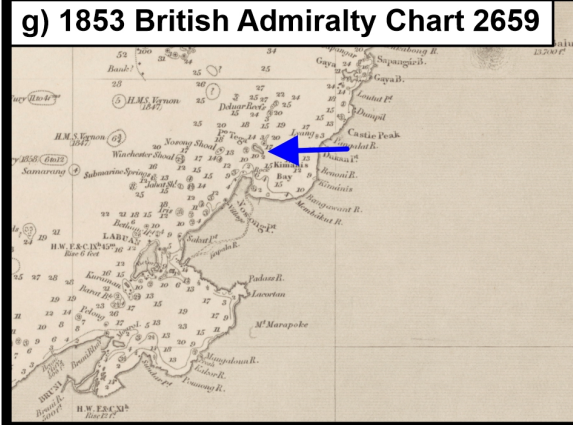
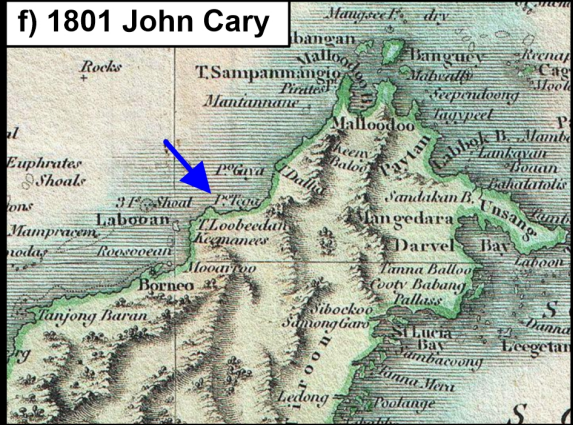
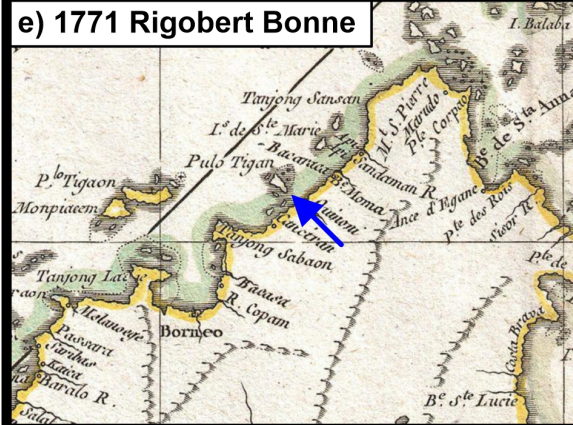
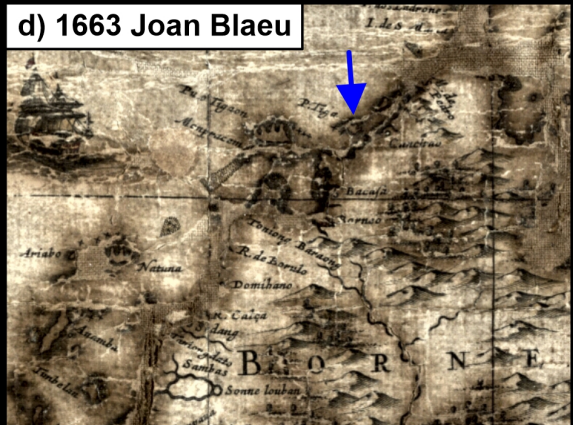
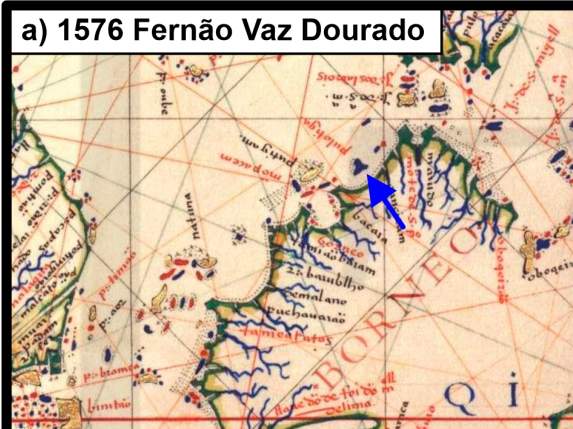


Figure 3: A selection of maps on which Pulau Tiga is plotted (blue arrows) and specifically labeled (as either “Tiga” or similar) dating from 1576 to 1888. These maps demonstrate that Pulau Tiga did not suddenly appear in 1897, and also indicate that the island has existed in a form similar to its current shape for several centuries. Note that North is towards the top of the page in all maps aside from (b) where East is to the top of the page.

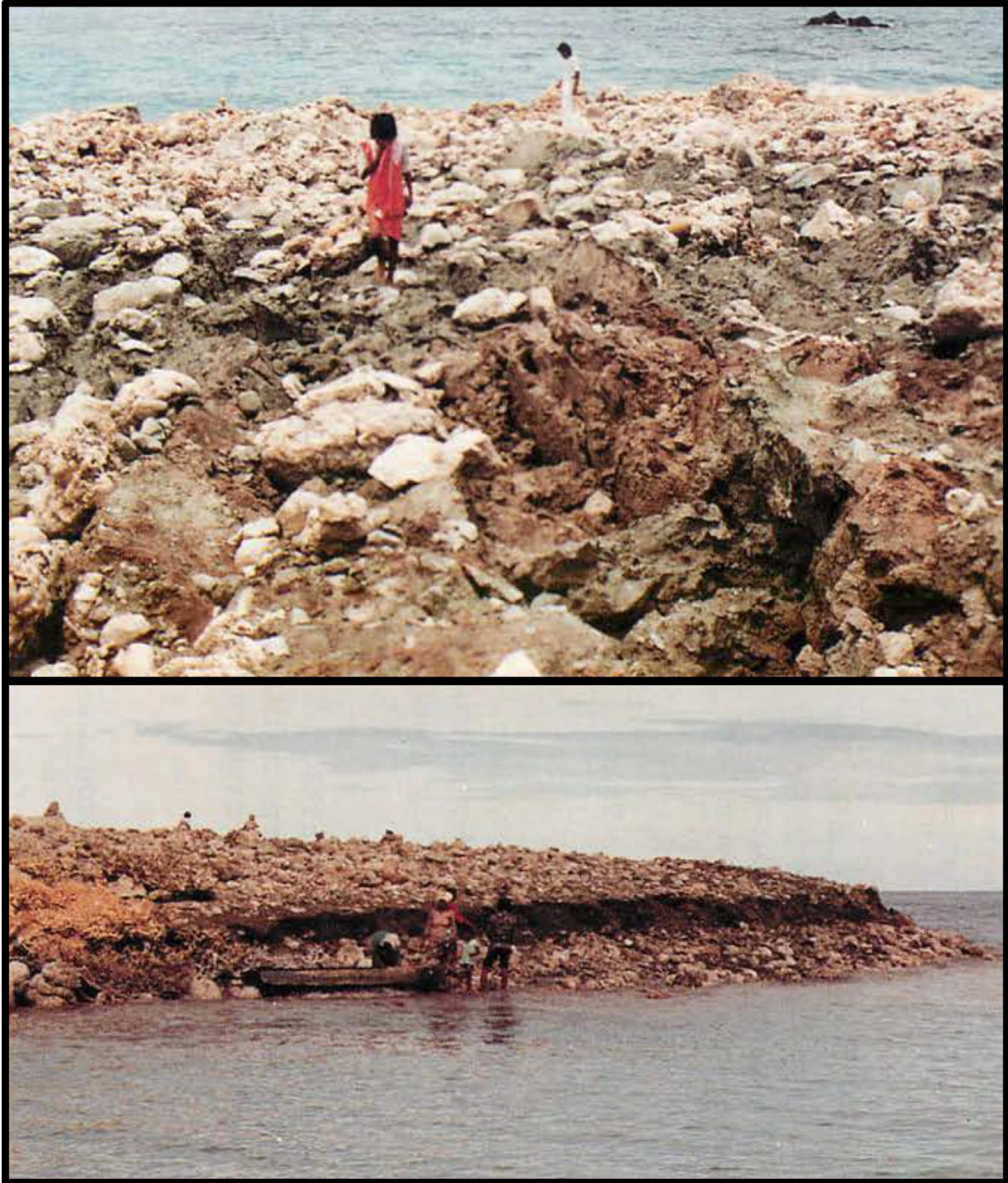


Figure 4: Images of the most recent appearance in 1988 of Pulau Batu Hairan mud volcano, offshore northern Borneo from Tongkul (1988). The appearance of the island in this photographs is consistent with the descriptions of the island that appeared in approximately the

same location in 1897 as described in Little (1898), such as being “*covered with large boulders of hard sandstone, coloured, like the whole island, of a greyish white. The substratum is fire-clay traversed by cracks running from north-east to south-west. Coral of various kinds is strewn over the surface, and the boulders are covered with small oysters.*” This suggests that this island that appeared in September 1897 was most likely an earlier and previously unrecognized eruption and emergence of the Pulau Batu Hairan mud volcano.

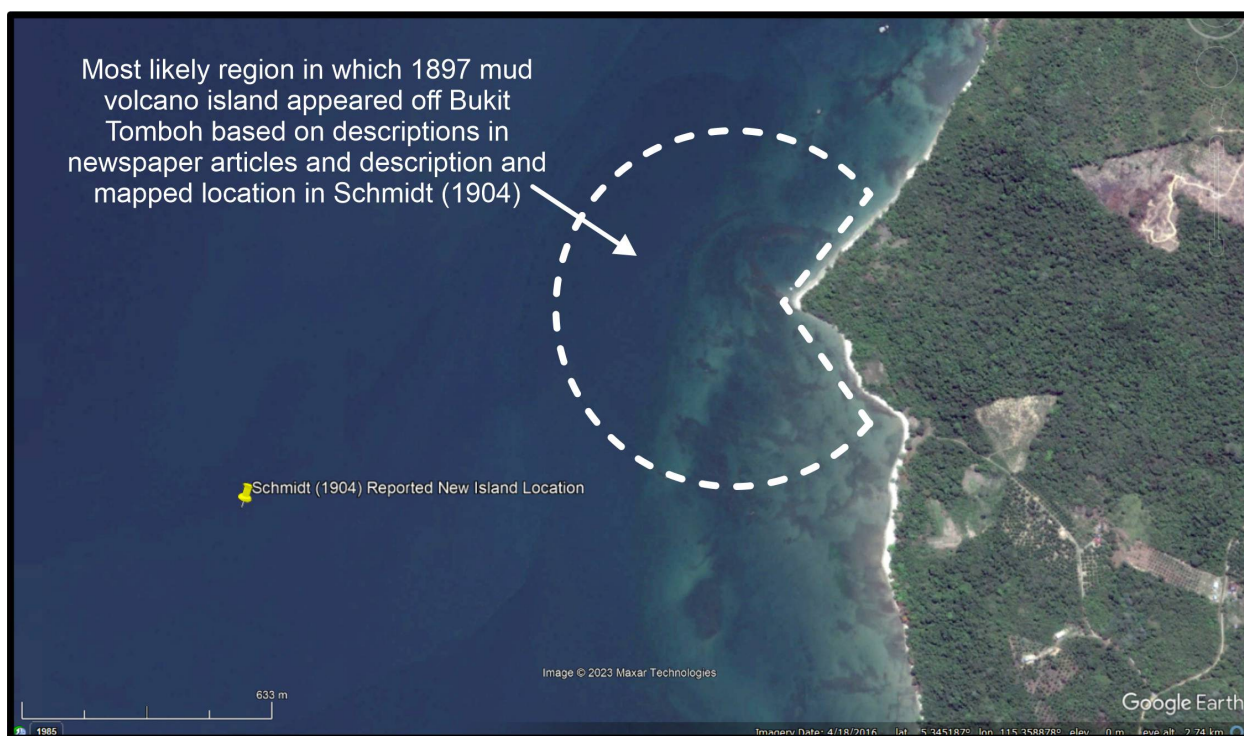


Figure 5: The estimated location of the mud volcano island that appeared on the 21st September 1897 off of Bukit Tomboh on the western Klias Peninsula (See Figure 1 for regional location). Eyewitness accounts published in *The North Borneo Herald* (1897) and a location description by Schmidt (1904), from his visit to the island in 1899, indicate the island was located somewhere in the white dashed area ($\sim 5.346^{\circ}\text{N}$, 115.361°E). However, it should be noted

that Schmidt (1904) also gives latitude and longitude locations that plot at the location given by the yellow pin. The latitude and longitude location in Schmidt (1904) is considered less accurate herein due to potential positioning errors at the time, and potential datum errors, and its clear discrepancy with the other descriptions in Schmidt (1904) and The North Borneo Herald (1897).



Figure 6: Photograph of the damage and mud flow from the 19th February 1941 eruption of the Southwest vent of the Pulau Tiga mud volcano, as reproduced in The Straits Budget on the 24th April 1941.