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GEOLOCATING SOUTHEAST ASIAN EARLY HISTORIC SITES FROM ASTRONOMICAL OBSERVATIONS IN PTOLEMY'S *GEOGRAPHY*, WITH SUPPORTING INFORMATION FROM INDIAN RECORDS

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Abstract: Southeast Asia is a multiethnic region with a long history, as toponyms such as *Suvarṇabhūmi* were mentioned in Indian records as early as the third century BCE. This study utilized astronomy, geography, and linguistics to geolocate Southeast Asian states and geographical features during the period between the third century BCE and the fifth century CE, which covers its early historic period. Ptolemy's *Geography*, which contains geographical knowledge from the early second century BCE, is the primary source of information from the Greek record. The results of astronomical computations from this ancient geographical corpus suggest that, in addition to the approximated locations derived from multiple navigators, the locations of some cities were likely computed using the date of the overhead Sun encoded with a type of local lunisolar calendar. Comparing the astronomically reconstructed maps to the modern map also indicates that Ptolemy's coastline is roughly similar to the actual one and can be used to locate cities such as *Takōla* and *Sabana* emporia to a reasonable level of certainty. The results of the etymological analysis also indicate that some indigenous toponyms translated into Greek, Pali, and Sanskrit are still in use today.

Keywords: Southeast Asia; Early Historic Period; maritime trade routes; geographical history; archaeoastronomy

1 INTRODUCTION

Studying the early historic period of Southeast Asia, which spans from the third century BCE to the fifth century CE, is crucial for many reasons, not least because the available evidence is frequently used. The region has a lengthy and intricate history shaped by numerous cultures and influences through the maritime trade route. However, a significant portion of Southeast Asian history and countless historical sites and artifacts have been irretrievably lost. Therefore, the geographical history of ancient Southeast Asia cannot be comprehended without historical documents recorded in different languages. These records contain information about past human activities and the physical changes in a particular region. By studying the early history of Southeast Asia from foreign records, scholars can gain a deeper understanding of the societies and cultures that existed in the region in the past and how they shaped the region as it exists today. This knowledge can also assist us in comprehending the current issues and challenges facing Southeast Asia, such as political conflicts and economic growth. Additionally, studying the early history of Southeast Asia can aid in the preservation of the region's cultural heritage and foster a greater appreciation for the diversity of its people and cultures.

1.1 Roman and Greek Records

The increased traffic along the maritime trade route at the beginning of the Christian era encouraged Westerners to study Southeast Asia in more detail (Borell, 2018; Braddell, 1937; 1941; Majumdar, 1937: 100; Pachow, 1960; Xiong and Lin, 2018). In the *Chorographia* of Pomponius Mela from the mid-first century CE, continental Southeast Asia is called the *Tamus* Promontory. Also, in its vicinity is the *Chryse Insula* (the golden island, more likely referred to the Thai-Malay Peninsula), and near the Ganges River is the *Argyre Insula* (the silver island, likely the coastal region of Arakan in Myanmar) (Braddell, 1936; Majumdar, 1937: 39; Suarez, 1999: 62; Wheatley, 2017: 127–129). Around the same time, the *Períplous tês Erythrâs Thalássēs* (lit. the Periplus of the Red Sea) also mentions a large ship called *Kolan-*

diophōnta, which made regular voyages between port cities along the eastern coast of India, the Ganges River, and *Chrysē* in Southeast Asia (Beaujard, 2019: 403–404; Bennett, 2018; Borell, 2018; Braddell, 1936; Lankton and Gratuze, 2018; Majumdar, 1937: 39, 42, 49–50; Ray, 2018; Wheatley, 2017: 191, 283). Some years later, in 77 CE, the *Naturalis Historia* by Pliny the Elder refers to the *Tamus* Promontory as the *Chryse* Promontory, while the gold and silver islands were moved away to the mouth of the Indus River (Braddell, 1936; Majumdar, 1937: 39; Suarez, 1999: 62–63; Wheatley, 2017: 129). Subsequent authors from the second to the sixth centuries CE, such as Dionysius Periegetes, Solinus, Avienus, Martianus Capella, and Priscianus, placed the *Chryse* Island either at the extreme east of the world or at the mouth of the Ganges River (Majumdar, 1937: 39–40; Wheatley, 2017: 131–135; Xiong and Lin, 2018).

Among Roman and Greek records, ancient states in Southeast Asia can be geolocated with the highest accuracy using coordinates provided in Claudius Ptolemy's *Geōgraphikè Hyphḗgēsis* (henceforth Ptolemy's *Geography*) written in Greek in the second century CE. In this record, later divided into eight volumes, Southeast Asia is referred to in the seventh volume as India outside of the Ganges (*Ektos Ganggos Indiaē*), and the Thai-Malay Peninsula is referred to as the Golden Peninsula (*Chrysē Chersonēsos*) (Berggren and Jones, 2000: 17; Borell, 2018: 59–60; Braddell, 1936; McCrindle, 1927: xxii, 197–198; Renou, 1925: 42, 45; Wheatley, 2017: 138). Marinus of Tyre documented early second-century CE knowledge of several locations, including a map of the known world to the Greeks, before transmitting these as the primary source for Ptolemy's *Geography* (Beaujard, 2019: 409; Bennett, 2018; Berggren and Jones, 2000: 4, 23–25, 27, 63–64; Borell, 2018; Marx, 2012; McCrindle, 1927: xiv, xviii–xix, 3; Russo, 2013; Suarez, 1999: 63–64). In his lost geography treatise, Marinus included descriptions of his trip experiences and those of others. These descriptions provide the names of important ports along the maritime trade routes, including sailing distance and direction between stops. Ptolemy quoted some of his instructions on sea travel from southern India to the Chinese mainland and gave additional comments in the first volume of his work (Berggren and Jones, 2000: 155–156).

Along the Southeast Asian coastline, the seventh volume of Ptolemy's *Geography* includes a list of toponyms and their physical coordinates, as well as descriptions of mountains, rivers, islands, towns, and ethnic groups (Braddell, 1936; McCrindle, 1927: 189–244; Renou, 1925: 42–61; Suarez, 1999: 84–86; Wheatley, 2017: 139–140). However, it appears that modern-day recensions of Ptolemy's *Geography* were copied or translated into other languages (particularly Latin) from the only Greek recension discovered by Maximos Planudes at the beginning of the fourteenth century (Berggren and Jones, 2000: 5, 42–50, 52–53; Rawlins, 2009). Studying these Greek names and their coordinates can result in various distortions. Therefore, only one toponym of each site considered the closest to an actual geographical name will be romanized and used throughout this paper.

1.2 Indian Records

Indian records from the third century BCE are the earliest evidence of the legend of *Suvarṇabhūmi* (Sanskrit for the Golden Land), considered a land of wealth since antiquity. (Scholars continue to search for the location of this Golden Land to this day, but most agree that it is located in Southeast Asia.) These documents contain the semantic treatise *Arthaśāstra* by *Kauṭilya*, which mentions a *Suvarṇabhūmi* agarwood named *Agāru* (Beaujard, 2019: 478; Sarkar, 1981; Wheatley, 2017: 181). *Mahāniddesa*, a Buddhist Pali scripture, contains a list of important port cities at the time, which includes *Gumba*, *Takkola*, *Takkasila*, *Kālamukha*, *Pahammukha*, *Vesuṇga*, *Verāpatha*, *Java*, *Tāmali*, *Vaṇka*, *Eḷavaddhana*, *Suvaṇṇakaṭa*, *Suvaṇṇabhūmi*, *Tambapaṇṇi*, *Suppāraga*, *Bharukaccha*, *Suraṭṭha*, *Aṇgaloka*, *Gaṇgaṇa*, *Paramagaṇgaṇa*, *Yona*, *Pinaka*, *Allasaṇḍa*, and *Marukantāra* (Beaujard, 2019: 479; Bennett, 2018; Braddell, 1939; Sarkar, 1981; Srisuchat, 2014: 63; Wheatley, 2017: 181). Another Buddhist Pali scripture called *Milindapañhā* from the third to the fourth century CE also contains another list which includes *Vaṇga*, *Takkola*, *Cīna*, *Sovīra*, *Suraṭṭha*, *Alasanda*, *Kolapaṭṭana*, and *Suvaṇṇabhūmi* (Beaujard, 2019: 479; Sarkar, 1981; Srisuchat, 2014: 65; Wheatley, 2017: 181, 269). In addition, commentaries of Buddhist Pali canons, such as *Samantapāsādikā*, *Manorathapūraṇī*, *Paramatthadīpanī*, and *Visuddhajanavilāsinī*, which are believed to be composed in the later period (but not older than the fifth century CE) still mentions *Suvaṇṇabhūmi* (Beaujard, 2019: 479).

These international seaports were also known to Western merchants and seafarers, such as those mentioned in Ptolemy's *Geography*, with their names appearing in the *Mahāniddesa* and *Milindapañhā*. These toponyms that are currently matchable through the process of transcription or transliteration and can

be located on modern-day maps are: *Takkasila* in Pali is *Taxiala* in Ptolemy's *Geography* (*Taxila* in Punjab, Pakistan), *Suraṭṭha* is *Syrastra* (on the Kathiawar Peninsula in Gujarat, India), *Bharukaccha* is *Barygaza* (Bharuch in Gujarat), *Supparaga* is *Soupara* (likely Nala Soupara in Maharashtra, India), *Tāmali* is *Tamalitēs* (near Patna in Bihar, India), *Tambapaṇṇi* is *Taprobanē* (Sri Lanka), and *Cīna* is *Sinai* (China) (Braddell, 1939).

Since the late fourth century CE, Buddhist missionaries and pilgrims frequently travelled between India, Southeast Asia, and China on merchant ships (Pachow, 1960). In Buddhist scriptures, such as the Nepalese *Mahākarmavibhaṅga* and the Burmese *Śāsanavaṃsa*, the conversion of *Suvaṇṇabhūmi* to Buddhism is attributed to a Buddhist monk named *Gavāmpati* who lived during the time of the Buddha (Ghosh, 2018; Majumdar, 1937: 39; Wheatley, 2017: 181). Buddhist texts written in Pali from Sri Lanka (such as *Dīpavaṃsa* and *Mahāvaṃsa* from the fourth to the fifth centuries CE) also mention *Suvaṇṇabhūmi* as the location where two Buddhist monks named *Soṇa* and *Uttara* were sent as missionaries during the first half of the third century BC (Bennett, 2018; Ghosh, 2018; Geiger, 1912: 82–87; Majumdar, 1937: 39; Srisuchat, 2014: 65; Wheatley, 2017: 181). Early Pali *Jātaka*, such as *Bāverujātaka*, *Sussondījātaka*, *Saṅkhajātaka*, *Supāragajātaka*, and *Mahājanakajātaka*, also mention Suvaṇṇabhūmi as a destination for sailors who seek wealth and prosperity (Beaujard, 2019: 479; Bennett, 2018; Ghosh, 2018; Lankton and Gratuze, 2018; Majumdar, 1937: 37; Sarkar, 1981; Skilling, 2018; Srisuchat, 2014: 67; Suarez, 1999: 45; Wheatley, 2017: 179).

This study reinterprets the locations of early historic Southeast Asian states by analyzing historical records written in Greek, Pali, and Sanskrit using interdisciplinary approaches, including archaeoastronomy, geography, and etymology. This study aims to: (1) convert all of the Southeast Asian coordinates in Ptolemy's *Geography* into modern geographical coordinates and (2) associate this geoinformation to pair toponyms in Greek and Indian records.

2 MATERIALS AND METHODS

2.1 Computing Geographical Coordinates from Ptolemy's *Geography*

Numerous Southeast Asian coordinates in Ptolemy's *Geography* were derived from astronomical observations. It is possible to verify and cross-check these coordinates with the locations of ancient sites using archaeoastronomy. Using this method, it is also possible to convert Ptolemy's coordinates into modern latitudes and longitudes. This technique enables a more precise understanding of the ancient sites and provides new information for interpreting their actual locations on modern maps. This is because archaeoastronomy can give a deeper understanding of ancient astronomical knowledge and how it was utilized in the placement of sites. In addition, cross-checking the coordinates in this manner can be used to verify the accuracy of Ptolemy's calculations, thereby increasing confidence in the accuracy of the other coordinates in his legacy work.

Modern research has demonstrated that the geographical coordinates stated in Ptolemy's *Geography* are unreliable. Because the majority of coordinates were likely estimates based on the accounts of sailors and travelers. Only a portion of these coordinates has been directly determined from astronomical observations. The observational data is included in the eighth volume of his *Geography* (Berggren and Jones, 2000: 19–20, 28, 42, 50, 59). In addition, Ptolemy's use of an incorrect circumference of the Earth also led to consistently faulty longitude and latitude results (McCrindle, 1927: xx–xxii, 3–6; Suarez, 1999: 82–83). Ptolemy computed the longitude using his version of the prime meridian (which passes through unknown isles in the Atlantic Ocean along the longitude of 11.94° W) and computed the latitude using the Tropic of Cancer. Consequently, sites further away from these two reference lines have a more significant cumulative disparity (Berggren and Jones, 2000: 14; Marx, 2012; Rawlins, 2009; Russo, 2013).

In the eighth volume of his *Geography*, as well as in the *Almagest*, another work of his on astronomy, Ptolemy calculated the coordinates of some 'important' or 'noteworthy' cities that were listed there (Berggren and Jones, 2000: 19–21, 42, 50; Marx, 2012; Rawlins, 2009). These cities are given their astronomical observations, which include the time difference from the meridian of Alexandria in equinoctial hours (can be calculated from the local time between two locations during the same lunar eclipse) and the length of the longest day in equinoctial hours (can be observed directly from the sundial at each place, used to compute the latitude) (Berggren and Jones, 2000: 19, 29–30, 59–61; Marx, 2012; Rawlins, 2009; Russo, 2013). In the case of Southeast Asia and other places situated south of the Tropic of Cancer, Ptolemy also gave the angular distance in degrees between the summer solstice and the Sun when it reaches the zenith at each place (can be computed from the date when the simple sundial casts no shadow twice a year, also used to compute the latitude) (Marx, 2012; Rawlins, 2009).

In the eighth volume of Ptolemy's *Geography*, the time difference between an unidentified island along Ptolemy's prime meridian and Alexandria is 4 hours (equal to 60° of longitude), whereas, in the fourth volume, Alexandria's longitude is 60.5° (Rawlins, 2009). The similarity of these numbers indicates that the time differences of all cities listed in the eighth volume are derived not from direct astronomical observations but from modified results from Ptolemy's distorted world map. According to Russo (2013), Ptolemy's longitude L is straightforwardly related to modern geographical longitude λ as

$$\lambda(L) = (L - 17.05°) / 1.428. \quad (1)$$

Note that this equation's parameters were estimated using location data that do not extend beyond modern-day longitudes of approximately 60° E, whereas all Southeast Asian locations are beyond 90° E. However, it is likely that longitude determination using lunar or solar eclipses has never been performed in Southeast Asia, given the rarity of this phenomenon and the specialized observational skills required. Ptolemy and his predecessors had to reconstruct the world map based on the accounts of sailors and merchants. Therefore, it is necessary to apply Equation (1) to the Southeast Asia data to compute geographical longitudes in this study, as there is no other preferable solution.

Observing the equinoctial hours of the daytime's duration at a given latitude is also difficult, as the sundial only provides the apparent solar time. It is possible that the longest daytime durations given in the eighth volume of Ptolemy's *Geography* are not derived from sundial observations, as there is no evidence of the availability of a standard or reliable system to convert the apparent time into the mean time in ancient Southeast Asia. Consequently, the only astronomical observation that can be made in this region is the angular distance along the ecliptic when the Sun is perpendicular to each location. The calendar date of this twice-yearly occurrence was likely transmitted to Ptolemy, who encoded it as an angular distance for use in specific computations.

Using spherical trigonometry (Figure 1 (a)), the angular distance S between the summer solstice and the overhead Sun for latitude ϕ can be computed from

$$S(\phi) = \arccos(\sin\phi \csc\varepsilon), \quad (2)$$

where ε is the obliquity of the ecliptic (Marx, 2012; Rawlins, 2009). Following Marx (2012), it was found that Ptolemy approximated this relation in the form of a piecewise linear function S' using his latitudes B and his obliquity of the ecliptic $\varepsilon' = 23° 50'$ (Figure 1 (b)):

$$S'(B) = -2.40B + 90.00° \text{ for } 0° \le B < 12.5° \quad (3a)$$
$$S'(B) = -3.87B + 108.39° \text{ for } 12.5° \le B < 20.25° \quad (3b)$$
$$S'(B) = -8.37B + 199.53° \text{ for } 20.25° \le B < \varepsilon' \quad (3c)$$

All latitudes in Ptolemy's *Geography* can be converted back to S' using Equation (3), although it cannot be guaranteed that all Southeast Asian latitudes were derived from sundial observations. These S' values are related to the time when the overhead Sun phenomenon occurred and the Southeast Asian natives' calendar system. This study proposes that the geographical latitude computed using Ptolemy's latitudes can be modified by adding an offset parameter S_0 such that

$$S(B) = S'(B) + S_0. \quad (4)$$

Finally, the geographical latitude can be computed based on Equation (2), but now using the true obliquity of the ecliptic $\varepsilon = 23° 41' 25''$ at 100 CE (Figure 1(c)), following

$$\phi = \arcsin(\cos(S'(B) + S_0)\sin\varepsilon). \quad (5)$$

As most Southeast Asia cities in Ptolemy's *Geography* cannot be precisely located on a modern map, their latitudes cannot be used to determine the S' value. Geographical landmarks, such as river mouths, promontories, capes, and gulfs, should be utilized as the optimal locations. However, over the course of two thousand years, the location of a river mouth can change dramatically, while a cape is too small to be certainly located at its true location, and a gulf is too large to be pinpointed with a single point. Therefore, the remaining landmarks are promontories, including those beyond *Tamala*, *Bērabai*, *Takōla*, and the one at the beginning of the Great Gulf.

The value of S' was chosen, not mathematically but rationally, to minimize the difference between B and ϕ for each promontory. This study assumed that:

(1) The promontory beyond *Tamala* is Cape Negrais in Ayeyarwady, Myanmar,
(2) The promontory beyond *Bērabai* is Victoria Point in Kawthaung, Myanmar,
(3) The promontory beyond *Takōla* is Cape Promthep in Phuket, Thailand, and
(4) The promontory before the Great Gulf is Cape Ca Mau, the southernmost point of Vietnam.

An initial experiment revealed that it is impossible to find a single value of S_0 that matches all of Ptolemy's latitudes to proposed modern locations. Nonetheless, it can be observed that the estimated S_0 of the promontories beyond *Bērabai* and *Takōla* are close together, at approximately $S_0 = -14.6°$ (Table 1). This value will be used in Equation (5) to

convert Ptolemy's latitudes to modern geographical latitudes. Note that using this value will improve the accuracy of locations in the Thai-Malay Peninsula while decreasing the accuracy of lo-cations further away.

The value S_0 = −14.6° is close to half the duration of a synodic month of approximately 29.53 days and is the basis for the lunisolar calendar used in India and Southeast Asia. This offset value is likely due to the different Hindu lunar month reckoning systems: the *Amānta* system, which concludes the lunar month on the day of the New Moon (popular in the southern half of India and Southeast Asia), and the *Pūrṇimānta* system, which concludes it on the day of the Full Moon (prevails in the northern half of India). The Greeks may have inherited information about the calendar dates of the overhead Sun in Southeast Asia (particularly the Thai-Malay Peninsula) without realizing that these dates are based on a different calendrical system.

2.2 Association Between Greek, Pali and Sanskrit Toponyms

Using the comparative linguistic technique, the approximated geographical coordinates of every Greek toponym can be etymologically examined alongside its possible original names in Pali and Sanskrit (Lyons, 1968). In the case of Southeast Asia, preliminary examination indicates that most foreign toponyms are loanwords or calques, possibly derived from their indigenous names in the ancient Malay and Mon languages. The techniques by which a toponym in multiple languages is derived from its native name are transcription, transliteration, and translation (Bloomfield, 1984). When combined with maps reconstructed from Ptolemy's *Geography*, this etymological analysis can provide unprecedented detail regarding the early historical geography of Southeast Asia.

3 RESULTS AND DISCUSSION

3.1 Mainland Southeast Asia Reconstructed from Ptolemy's *Geography*

Although the descriptions of the Indian subcontinent and Southeast Asia in Ptolemy's *Geography* are highly inaccurate, in modern-day maps, the coastlines of both regions are still comparable (see Table 2 and Figure 2). The second chapter of its seventh volume, titled "Position of India outside the Ganges", contains coordinates of coastal settlements (such as a warehouse or may refer to a port, emporium, city, and metropolis) and geographical landmarks significant for navigation (including river mouth, gulf, cape, and promontory) in various regions along the coastline of Mainland South-

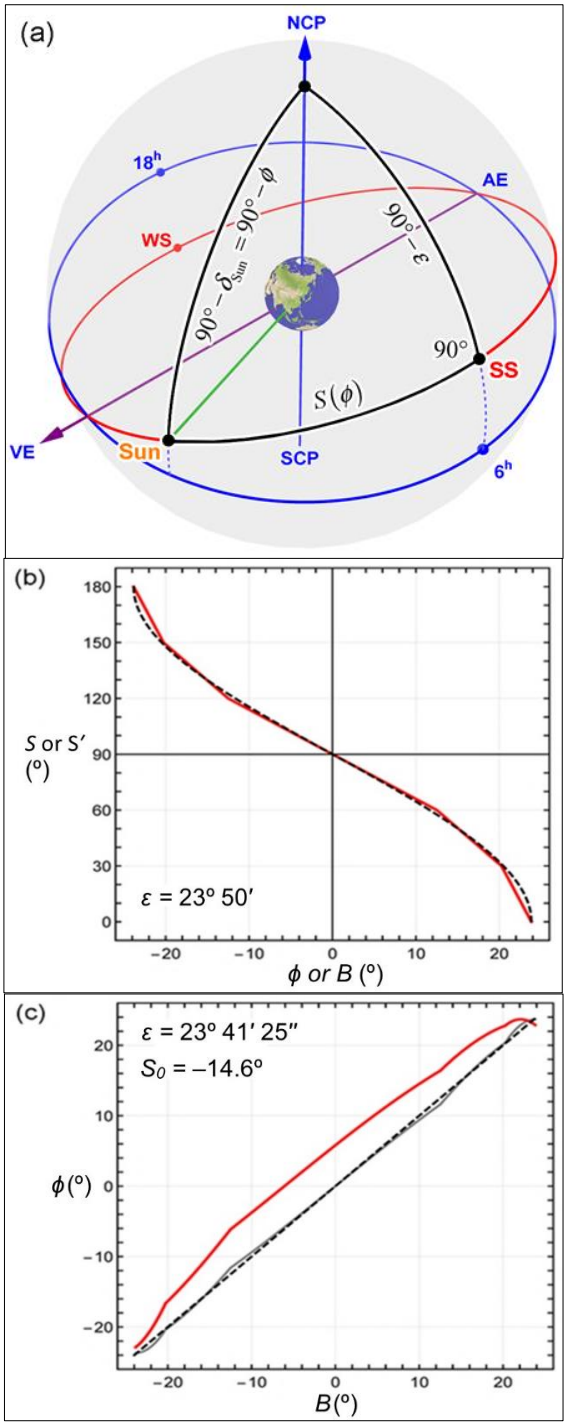

Figure 1: The celestial sphere (a) depicts the spherical triangle (black lines) relating the observer's geographical latitude ϕ to the angular distance $S(\phi)$ of the overhead Sun from the summer solstice (SS) along the ecliptic when the Sun is at the declination of δ_{Sun} (other abbreviations in (a) are vernal equinox: VE, autumnal equinox: AE, winter solstice: WS, north celestial pole: NCP, and south celestial pole: SCP). The actual function between ϕ and $S(\phi)$ derived using spherical trigonometry is shown as a dashed line in (b) while its approximated version $S'(B)$ (Equation (3)) which was extended to cover the negative value of Ptolemy's latitude B is shown as a red line in (b). This function was used to convert from B to ϕ using Equation (5), with zero offset S_0 = 0° giving a direct function (grey line in (c)) which nearly represents the one-to-one function (dashed line in (c)), while the chosen approximated offset S_0 = −14.6° gives the higher ϕ than B (red line in (c)).

Table 1: This table shows the estimated values of S_0 specific to each promontory in Southeast Asia mentioned in Ptolemy's *Geography*. For the promontories beyond Bērabai and Takōla, their estimated value is approximately $S_0 = -14.6°$, which will be used in converting Ptolemy's latitudes to geographical latitudes.

Ptolemy's Location	Modern-day Location	Ptolemy's Latitude (° N)	Geographical Latitude (° N)	Estimated S_0 (°)
Promontory beyond *Tamala*	Cape Negrais, Myanmar	8°	16° 02' 32"	−24° 15' 18"
Promontory beyond *Bērabai*	Victoria Point, Myanmar	4° 20'	9° 58' 27"	−15° 08' 08"
Promontory beyond *Takōla*	Cape Promthep, Thailand	2° 20'	7° 46' 57"	−14° 05' 45"
Promontory before the Great Gulf	Cape Ca Mau, Vietnam	4° 15'	8° 37' 54"	−11° 44' 02"

Table 2: This table shows the original longitudes and latitudes (L and B) given in Ptolemy's *Geography*, geographical longitudes and latitudes (λ and ϕ) computed using Equations (1) and (5), and their residuals. Southeast Asian locations with original latitudes of more than the value of Ptolemy's obliquity of the ecliptic $\varepsilon' = 23° 50'$ will be excluded. Location type abbreviations are city or town (T), emporium (E), metropolis (M), capital city (Cc), river mouth (R), promontory (P), cape (C), gulf (G) and island (I). Abbreviations marked with an asterisk (*) are inland towns.

Type	Name	L (°)	λ (°)	$\lambda - L$ (°)	B (°)	ϕ (°)	$\phi - B$ (°)
			Kirradeōn				
T	*Mentapolis*	150° 0'	93° 6' 8"	−56.90°	18° 0'	21° 30' 40"	3.51°
R	*Katabēda*	151° 20'	94° 2' 9"	−57.30°	17° 0'	20° 46' 44"	3.78°
E	*Barakoura*	152° 0'	94° 30' 10"	−57.50°	16° 0'	19° 57' 5"	3.95°
R	*Tokosana*	153° 0'	95° 12' 11"	−57.80°	14° 30'	18° 32' 34"	4.04°
Cc*	*Triglyphon* or *Trilingon*	154° 0'	95° 54' 12"	−58.10°	18° 0'	21° 30' 40"	3.51°
			Argyra Chōra (the Silver Country)				
T	*Sambra*	153° 30'	95° 33' 12"	−57.95°	13° 45'	17° 46' 7"	4.02°
R	*Sados*	153° 30'	95° 33' 12"	−57.95°	12° 30'	16° 22' 56"	3.88°
T	*Sada*	154° 20'	96° 8' 12"	−58.20°	11° 20'	15° 32' 2"	4.20°
E	*Bērabona*	155° 30'	96° 57' 14"	−58.55°	10° 20'	14° 46' 31"	4.44°
R	*Tamalos*	157° 0'	98° 0' 15"	−59.00°	10° 0'	14° 31' 2"	4.52°
T	*Tamala*	157° 30'	98° 21' 16"	−59.15°	9° 0'	13° 43' 38"	4.73°
P	Promontory beyond *Tamala*	157° 20'	98° 14' 15"	−59.10°	8° 0'	12° 54' 56"	4.92°
M*	*Mareoura*	155° 0'	96° 36' 13"	−58.40°	12° 30'	16° 22' 56"	3.88°
			Bēsyngitai				
T	*Sabara*	159° 30'	99° 45' 18"	−59.75°	8° 30'	13° 19' 27"	4.82°
E	*Bēsynga*	162° 0'	101° 30' 20"	−60.49°	9° 0'	13° 43' 38"	4.73°
R	*Bēsyngas*	162° 20'	101° 44' 21"	−60.59°	8° 20'	13° 11' 19"	4.86°
T	*Bērabai*	162° 20'	101° 44' 21"	−60.59°	6° 0'	11° 13' 57"	5.23°
P	Promontory beyond *Bērabai*	159° 0'	99° 24' 17"	−59.60°	4° 20'	9° 46' 35"	5.44°
			Chrysē Chersonēsos (the Golden Peninsula)				
E	*Takōla*	160° 30'	100° 27' 19"	−60.04°	4° 15'	9° 42' 9"	5.45°
P	Promontory beyond *Takōla*	158° 20'	98° 56' 16"	−59.40°	2° 20'	7° 58' 29"	5.64°
R	*Chrysoana*	159° 0'	99° 24' 17"	−59.60°	1° 0'	6° 44' 47"	5.75°
E	*Sabana*	160° 0'	100° 6' 18"	−59.89°	0° 20' S	5° 29' 59"	5.83°
R	*Palandos*	161° 0'	100° 48' 19"	−60.19°	2° 0' S	3° 55' 17"	5.92°
C	*Meleou Kolon*	163° 0'	102° 12' 21"	−60.79°	2° 0' S	3° 55' 17"	5.92°
R	*Attaba*	164° 0'	102° 54' 22"	−61.09°	1° 0' S	4° 52' 15"	5.87°

Type	Name	*L* (°)	*λ* (°)	*λ*−*L* (°)	*B* (°)	*ϕ* (°)	*ϕ*−*B* (°)
T	*Kōlē*	164° 20'	103° 8' 23"	−61.19°	0° 0'	5° 48' 46"	5.81°
T	*Perimoula*	163° 15'	102° 22' 51"	−60.87°	2° 20'	7° 58' 29"	5.64°
G	*Perimoulos*	162° 30'	101° 51' 21"	−60.64°	4° 15'	9° 42' 9"	5.45°
T*	*Kalonka*	162° 0'	101° 30' 20"	−60.49°	4° 20'	9° 46' 35"	5.44°
T*	*Konkonagara*	162° 0'	101° 30' 20"	−60.49°	2° 30'	8° 7' 37"	5.63°
T*	*Tharra*	163° 15'	102° 22' 51"	−60.87°	1° 20' S	4° 33' 18"	5.89°
T*	*Palanda*	161° 15'	100° 58' 49"	−60.27°	1° 30' S	4° 23' 49"	5.90°
Lēstōn Chōra (Robbers' Country)							
T	*Samaradē*	163° 30'	102° 33' 22"	−60.94°	4° 50'	10° 13' 5"	5.38°
T	*Patrasa*	165° 0'	103° 36' 23"	−61.39°	4° 50'	10° 13' 5"	5.38°
R	*Sōbanos*	165° 20'	103° 50' 24"	−61.49°	4° 45'	10° 8' 41"	5.39°
E	*Thipinobastai*	166° 20'	104° 32' 25"	−61.79°	4° 45'	10° 8' 41"	5.39°
T	*Akadra*	167° 0'	105° 0' 25"	−61.99°	4° 45'	10° 8' 41"	5.39°
T	*Zabai*	168° 20'	105° 56' 27"	−62.39°	4° 45'	10° 8' 41"	5.39°
Megalos Kolpos (the Great Gulf)							
P	Promontory before the great gulf	169° 0'	106° 24' 27"	−62.59°	4° 15'	9° 42' 9"	5.45°
T	*Thagora*	168° 0'	105° 42' 26"	−62.29°	6° 0'	11° 13' 57"	5.23°
M	*Balonga*	167° 30'	105° 21' 26"	−62.14°	7° 0'	12° 5' 1"	5.08°
T	*Throana*	167° 0'	105° 0' 25"	−61.99°	8° 30'	13° 19' 27"	4.82°
R	*Doanas*	167° 0'	105° 0' 25"	−61.99°	10° 0'	14° 31' 2"	4.52°
M	*Kotara*	167° 0'	105° 0' 25"	−61.99°	12° 30'	16° 22' 56"	3.88°
T	*Sinda*	167° 15'	105° 10' 55"	−62.07°	13° 20'	17° 19' 10"	3.99°
T	*Pagrasa*	167° 30'	105° 21' 26"	−62.14°	14° 30'	18° 32' 34"	4.04°
R	*Dorias*	168° 0'	105° 42' 26"	−62.29°	15° 30'	19° 30' 12"	4.00°
T	*Aganagara*	169° 0'	106° 24' 27"	−62.59°	16° 20'	20° 14' 15"	3.90°
R	*Sēros*	171° 30'	108° 9' 30"	−63.34°	17° 20'	21° 2' 2"	3.70°
Inland Towns of India Outside the Ganges							
M*	*Tōsalei*	150° 0'	93° 6' 8"	−56.90°	23° 20'	23° 16' 49"	−0.05°
T*	*Adeisaga*	159° 30'	99° 45' 18"	−59.75°	23° 0'	23° 28' 15"	0.47°
T*	*Kimara*	170° 0'	107° 6' 28"	−62.89°	23° 15'	23° 20' 0"	0.08°
T*	*Parisara*	159° 0'	99° 24' 17"	−59.60°	21° 30'	23° 35' 44"	2.10°
M*	*Tougma*	152° 30'	94° 51' 11"	−57.65°	22° 15'	23° 41' 2"	1.43°
T*	*Arisabion*	158° 30'	99° 3' 17"	−59.45°	22° 30'	23° 38' 46"	1.15°
T*	*Posinara*	162° 15'	101° 40' 50"	−60.57°	22° 50'	23° 32' 38"	0.71°
T*	*Pandasa*	165° 0'	103° 36' 23"	−61.39°	21° 20'	23° 32' 7"	2.20°
T*	*Sipibēris*	170° 0'	107° 6' 28"	−62.89°	21° 15'	23° 29' 58"	2.25°
T*	*Lariagara*	162° 30'	101° 51' 21"	−60.64°	18° 15'	21° 40' 44"	3.43°
T*	*Ringibēri*	166° 0'	104° 18' 24"	−61.69°	18° 0'	21° 30' 40"	3.51°
T*	*Agimoitha*	170° 40'	107° 34' 29"	−63.09°	18° 40'	21° 56' 40"	3.28°
T*	*Tamara*	172° 0'	108° 30' 30"	−63.49°	18° 0'	21° 30' 40"	3.51°

Type	Name	*L* (°)	*λ* (°)	*λ*−*L* (°)	*B* (°)	*ϕ* (°)	*ϕ*−*B* (°)
T*	*Doana*	165° 0'	103° 36' 23"	−61.39°	15° 20'	19° 20' 57"	4.02°
T*	*Lasypa*	161° 0'	100° 48' 19"	−60.19°	12° 30'	16° 22' 56"	3.88°
T*	*Bareuathra*	164° 30'	103° 15' 23"	−61.24°	12° 50'	16° 45' 47"	3.93°
Islands of India Outside the Ganges							
I	*Bazakata*	149° 30'	92° 45' 8"	−56.75°	9° 30'	14° 7' 30"	4.63°
I	*Salinē*	147° 0'	91° 0' 5"	−56.00°	9° 20'	13° 59' 35"	4.66°
I	*Sindai*	152° 20'	94° 44' 10"	−57.60°	8° 20' S	2° 10' 1" S	6.17°
I	*Agathou Daimonos*	145° 15'	89° 46' 33"	−55.47°	0° 0'	5° 48' 46"	5.81°
I	*Barousai*	152° 20'	94° 44' 10"	−57.60°	5° 20' S	0° 43' 23"	6.06°
I	*Sabadibai*	160° 0'	100° 6' 18"	−59.89°	8° 30' S	2° 19' 37" S	6.17°
Cc	*Argyrēn* (*Iabadios*, W.)	167° 0'	105° 0' 25"	−61.99°	8° 30' S	2° 19' 37" S	6.17°
I	*Iabadios*, E.	169° 0'	106° 24' 27"	−62.59°	8° 10' S	2° 0' 25" S	6.16°
I	*Satyrōn*	171° 0'	107° 48' 29"	−63.19°	6° 10' S	0° 4' 49" S	6.09°
I	*Maniolai*	142° 0'	87° 30' 0"	−54.50°	2° 0' S	3° 55' 17"	5.92°

east Asia (including the Thai-Malay Peninsula) and Maritime Southeast Asia.

3.1.1 *Kirradeōn*

This corresponds to the coastal region west of Chittagong in Bangladesh (McCrindle, 1927: 191; Renou, 1925: 43). *Kirradeōn* probably means 'the land of the *Kiratas*', in which this tribe now settles in Nepal. Toponyms in this region include

- *Mentapolis*: most likely the city of Chattogram or nearby area
- *Katabēda* River Mouth: near an island having a similar name, that is, the Kutubdia Island
- *Barakoura* Emporium: possibly the present-day city of Cox's Bazar
- *Tokosana* River Mouth: of the similar-name river called the Teknaf River

Further inland from this coastal region is a royal residence called *Triglyphon* or *Trilingon*.

3.1.2 *Argyra Chōra* (lit. the Silver Country)

This corresponds to the coastal region west of the Arakan Mountains in Myanmar (McCrindle, 1927: 196; Renou, 1925: 43–44). The resemblance between '*Arakan*' and '*Argyra*' suggests that the Greek name was transcribed from the indigenous name in use until relatively recently. The following are toponyms in this region, most of which cannot be associated with modern-day locations:

- *Sambra City*
- *Sados River Mouth*
- *Sada City*
- *Bērabona* Emporium: possibly the port city of Verāpatha in the Mahāniddesa
- *Tamalos* River Mouth
- *Tamala* City
- Promontory beyond *Tamala*: the southernmost point of the Arakan Mountains and the Irrawaddy Delta

Moreover, the Mareoura metropolis is undoubtedly the present-day city of Mrauk U in Rakhine State, Myanmar. This indicates that it is an important city that has retained its original name since ancient times.

3.1.3 *Bēsyngitai* or the land of *Bēsynga*

This is described as the cannibal tribe in Ptolemy's *Geography*, is located around the *Sabarakos* Gulf or the present-day Gulf of Martaban (McCrindle, 1927: 196; Renou, 1925: 44–45). Among the toponyms in this region are:

- *Sabara* City: can be equated with either Bago or Yangon, hence the name of the Sabarakos Gulf
- *Bēsynga* Emporium: most likely the city of Thaton or a nearby area, undoubtedly the port city of *Vesuṇga* in the *Mahāniddesa*
- *Bēsyngas* River Mouth: the Thanlyin River
- *Bērabai* City: the city of Dawei or nearby area
- Promontory beyond *Bērabai*: the Victoria Point in Kawthaung City at the southernmost point of Myanmar (located about 450 km south of Dawei).

3.1.4 *Chrysē Chersonēsos* (lit. the Golden Peninsula)

This is said in the first volume of Ptolemy's *Geography* to be one of the important islands

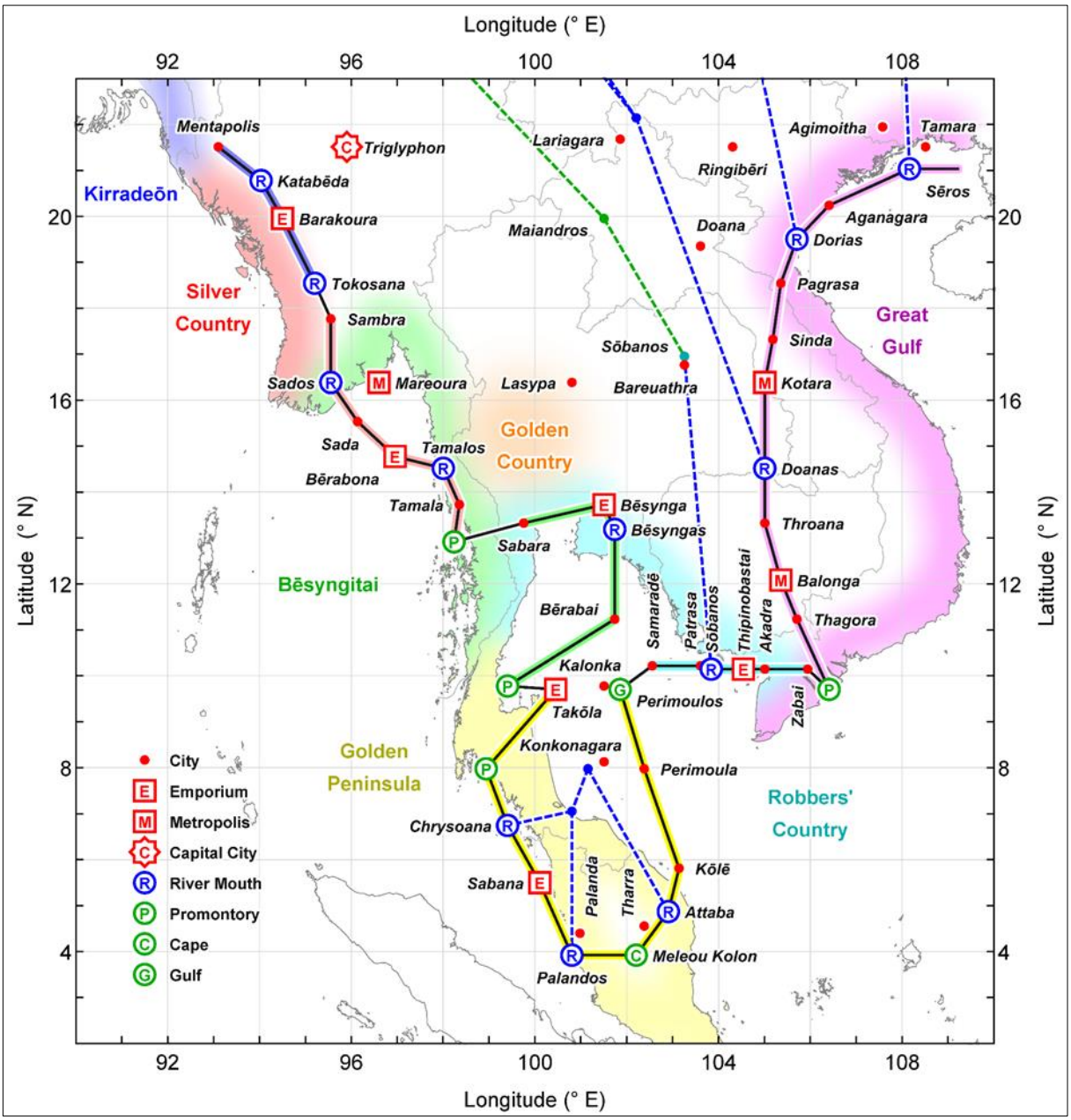

Figure 2: This map depicts several Southeast Asian locations in the second century CE compared to modern-day maps. The names and geographical coordinates of some locations may differ between recensions of Ptolemy's *Geography*. The locations along the coast are divided into regions perceived by Westerners at the time, with each region represented by a unique color. The grey line indicates the current coastline and administrative boundaries of the country. On this map, green dotted lines represent mountain ranges, while blue dotted lines represent rivers.

and peninsulas, corresponds to the Thai-Malay Peninsula from Ranong and Chumphon in southern Thailand down to Singapore (Berggren and Jones, 2000: 110; McCrindle, 1927: 197–198; Renou, 1925: 45–46). This peninsula consists of

- *Takōla* Emporium: Ranong in southern Thailand, on the western coast of the Kra Isthmus near the Promontory beyond *Bērabai* in Myanmar, undoubtedly the port city of *Takkola* in the *Mahāniddesa* (Koad and Rakmak, 2022)
- Promontory beyond *Takōla*: Cape Promthep in Phuket, in which ancient sailors viewed it as a promontory rather than an island
- *Chrysoana* River Mouth
- *Sabana* Emporium: southern Kedah in Malaysia, an important emporium of the Kalah Isthmus (Koad and Rakmak, 2022), possibly the port city of *Suvaṇṇakaṭa* in the *Mahāniddesa* (Figure 3)
- *Palandos* River Mouth: the last toponym on the western coast of the Golden Peninsula

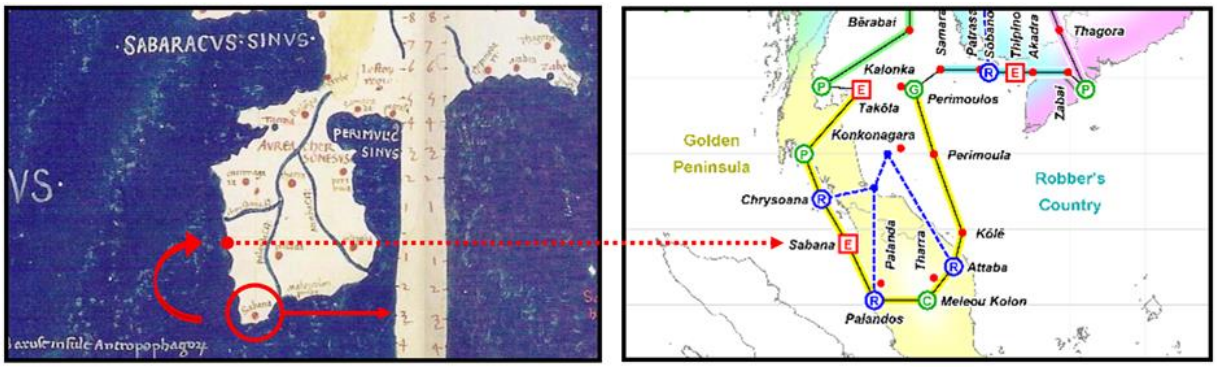

Figure 3: Most recensions of Ptolemy's *Geography* missed a sign in the latitude of *Sabana* Emporium (i.e., from *vót.* γ' to *vót.* γ). This puts its location in Ptolemy's map southward from 20′ S to 3° S (left). After correcting its latitude and recomputing its geographical coordinate, the new latitude of *Sabana* Emporium coincides with Kedah in Malaysia (right). Ptolemy's map on the left is a part of the eleventh map of Asia (*Descriptio Undecimae Tabulae Asia*, drawn in the fifteenth century CE) from the British Library Harley MS 7182.

- Cape *Meleou Kolon*: the first toponym on the eastern coast of the Golden Peninsula
- *Attaba* River Mouth
- *Kōlē* City: at the Ptolemy's equator
- *Perimoula*: now a part of Nakhon Si Thammarat in southern Thailand down to the Sathing Phra Peninsula in Songkhla
- *Perimoulos* Gulf: the Bandon Bay in Surat Thani

Common belief holds that *Sabana* is a port city located at the southernmost tip of the Thai-Malay Peninsula. Because many later-drawn Ptolemy's world maps appear to be based on incorrectly copied geographical coordinates from Ptolemy's *Geography*. Several recensions record the latitude of this port as *vót.* γ, which is equivalent to three degrees south of the equator, while the rest give *vót.* γ', which is equivalent to twenty arcminutes south (i.e., the former misses an arcminute symbol) (Renou, 1925: 45). This error, caused by the omission of a symbol during duplication, significantly alters the location of the *Sabana* emporium. By assuming that *vót.* γ' is correct; this coordinate coincides with the latitude of southern Kedah in Malaysia, which became an important port city called *Kaṭaha* in the sixth century CE (Figure 3) (Koad and Rakmak, 2022). Also, note that the Greek *Sabana* name is probably a transcription from the prefix of the Sanskrit name *Suvaṇṇakaṭa*, while *Kaṭaha* is likely its suffix.

3.1.5 *Lēstōn Chōra* (lit. Robbers' Country)

This is said to be the east-west oriented coastline located next to the *Perimoulos* Gulf (McCrindle, 1927: 202; Renou, 1925: 46). However, its orientation cannot be fitted with the actual coastline on the modern map, but a comparison with the *Sōbanos* River Mouth suggests that it stretches from Prachuap Khiri Khan in Thailand to Cambodia and southern Vietnam. Toponyms in this region include:

- *Samaradē*
- *Patrasa*
- *Sōbanos* River Mouth: the Chao Phraya River and its tributaries
- *Thipinobastai* Emporium
- *Akadra*
- *Zabai* City: probably the city of Oc Eo in southern Vietnam.

According to Ptolemy's *Geography*, the source of the *Sōbanos* River is deep inland in the *Maiandros* Mountains (McCrindle, 1927: 208; Renou, 1925: 50). By comparing the location of the source to the locations of other adjacent toponyms, it can be estimated that the source is located in northern Thailand at one of the Chao Phraya River's tributaries. Therefore, *Samaradē* and *Patrasa* should be situated west of the Chao Phraya River in Thailand, while *Thipinobastai* Emporium, *Akadra*, and *Zabai* City should be situated to its east.

There is also an inland region called *Chrysē Chōra* (lit. the Golden Country) described as "… juxtaposed to the *Bēsyngitai* …" in Ptolemy's *Geography*, indicating that this golden country is located in the central and western regions of Thailand (Figure 2) (McCrindle, 1927: 219; Renou, 1925: 53). Moreover, if a location in Ptolemy's *Geography* typically has multiple names, the other name will be listed together as synonyms. Therefore, it is likely that the Golden Country in central and western Thailand is distinct from the Golden Peninsula or the Thai-Malay Peninsula. Moreover, the Chao Phraya River, known as the *Sōbanos* River, seems likely to be the city's primary river with the same name. The Greek name *Chrysē Chōra* is likely *Suvarṇabhūmi*, which is located near a river called *'Suvarṇa'* in Sanskrit or *'Sōbanos'* in Greek.

3.1.6 *Megalos Kolpos* (lit. the Great Gulf)

This is the last region of India outside the Ganges. It corresponds to the long coastlines of Vietnam and southern China (McCrindle, 1927: 202–203; Renou, 1925: 46–47). This region includes

- the promontory where the gulf begins: most likely Cape Ca Mau in Vietnam
- *Thagora*
- *Balonga* Metropolis
- *Throana*
- *Doanas* River Mouth: the Mekong River
- *Kotara* Metropolis: possibly Kandarapura, the capital city of *Campā* (or *Línyì* in Chinese), proposed to be located in the city of Hue in central Vietnam
- *Sinda* City
- *Pagrasa*
- *Dorias* River Mouth: the Red River (also known as the Hong River)
- *Aganagara*
- *Sēros* River Mouth: the Nanliu River in China, after this, is the land of *Sinai* (or China)

Ptolemy's *Geography* describes that two sources of the *Doanas* River are located at the *Bēpyros* Mountains (at the eastern edge of the Himalayas, which is the Lancang River in China) and the *Dabasōn* Mountains (in Yunnan, China, which flows into the Ou River in Laos). The *Doanas* River begins at the confluence of the two rivers (at Pak Ou in Laos). It is clear that this river is the Mekong River which flows through China, Laos, Thailand, and Cambodia before entering the Pacific Ocean in southern Vietnam. The *Dorias* River to the north, which originates from the *Dabasōn* Mountains, is the Red River that runs into the Pacific Ocean in northern Vietnam.

Modern scholars are attempting to determine which rivers on the modern map correspond to the three rivers on the Golden Peninsula, including the *Chrysoana*, *Palandos*, and *Attaba* Rivers. These rivers flow down the east and west coasts of the Thai-Malay peninsula from the same unidentified mountain range which cannot be equated with any river as it appears today. Therefore, the previous hypotheses and their fabricated details cannot be used to identify these rivers within the scope of this study. Similarly, four other Golden Peninsula's inland cities, including *Kalonka*, *Konkonagara*, *Tharra*, and *Palanda*, are also geocoded differently in each recension such that their precise locations cannot be determined.

3.2 Maritime Southeast Asia Reconstructed from Ptolemy's *Geography*

In the seventh volume of Ptolemy's *Geography*, the coordinates of the islands, especially the Andaman and Nicobar Islands and the Indo-Malay Archipelago, are also a focus of interest (Figure 4) (see McCrindle, 1927: 236, 239; Renou, 1925: 58–61). These islands are

- The island of *Bazakata*: an island in the Andaman Islands
- The island of *Salinē*: another island in the Andaman Islands, said to be inhabited by the Aginatai cannibals
- Three islands of *Sindai*: likely refers to the Batu Islands near the city of Padang in West Sumatra, Indonesia, also said to be inhabited by cannibals
- The island of *Agathou Daimonos*: certainly the largest island of the Nicobar Islands named *Nāgadvīpa* in Sanskrit (named after a human-snake hybrid demon in ancient Greek mythology which looks like the Indian *Nāga*)
- Five islands of *Barousai*: likely refers to the Banyak Islands near the city of Barus in North Sumatra, Indonesia (note the similar pronunciation between the name '*Barousai*' and 'Barus'), also said to be inhabited by cannibals
- Three islands of *Sabadibai*: transcribed from the Sanskrit name *Suvarṇadvīpa* (which likely means the Golden Island rather than the Golden Peninsula) which includes Sumatra, Bangka, and Belitung Islands in Indonesia, also said to be inhabited by cannibals
- The island of *Iabadios*, which means 'the island of Barley', is an east-west oriented island with its capital city named *Argyrēn* at the western end of the island: undoubtedly the modern-day island of Java in Indonesia which was similarly called *Java* in the *Mahāniddesa* and *Yavadvīpa* in several Sanskrit manuscripts (Braddell, 1937)
- Three islands of *Satyrōn*, in which each inhabitant has a tail, like that of a satyr (a human-goat hybrid spirit in Greek mythology): likely refers to Borneo and nearby islands
- The magnetic islands of *Maniolai*, inhabited by cannibals: possibly the chain of islands along the Mentawai Forearc Sliver off the west coast of Sumatra (Berglar et al., 2017)

4 CONCLUDING REMARKS

Through maritime trade, continental Southeast Asia, the Thai-Malay Peninsula, and the Indo-Malay archipelago were known to foreigners, as indicated by ancient Greek and Indian records.

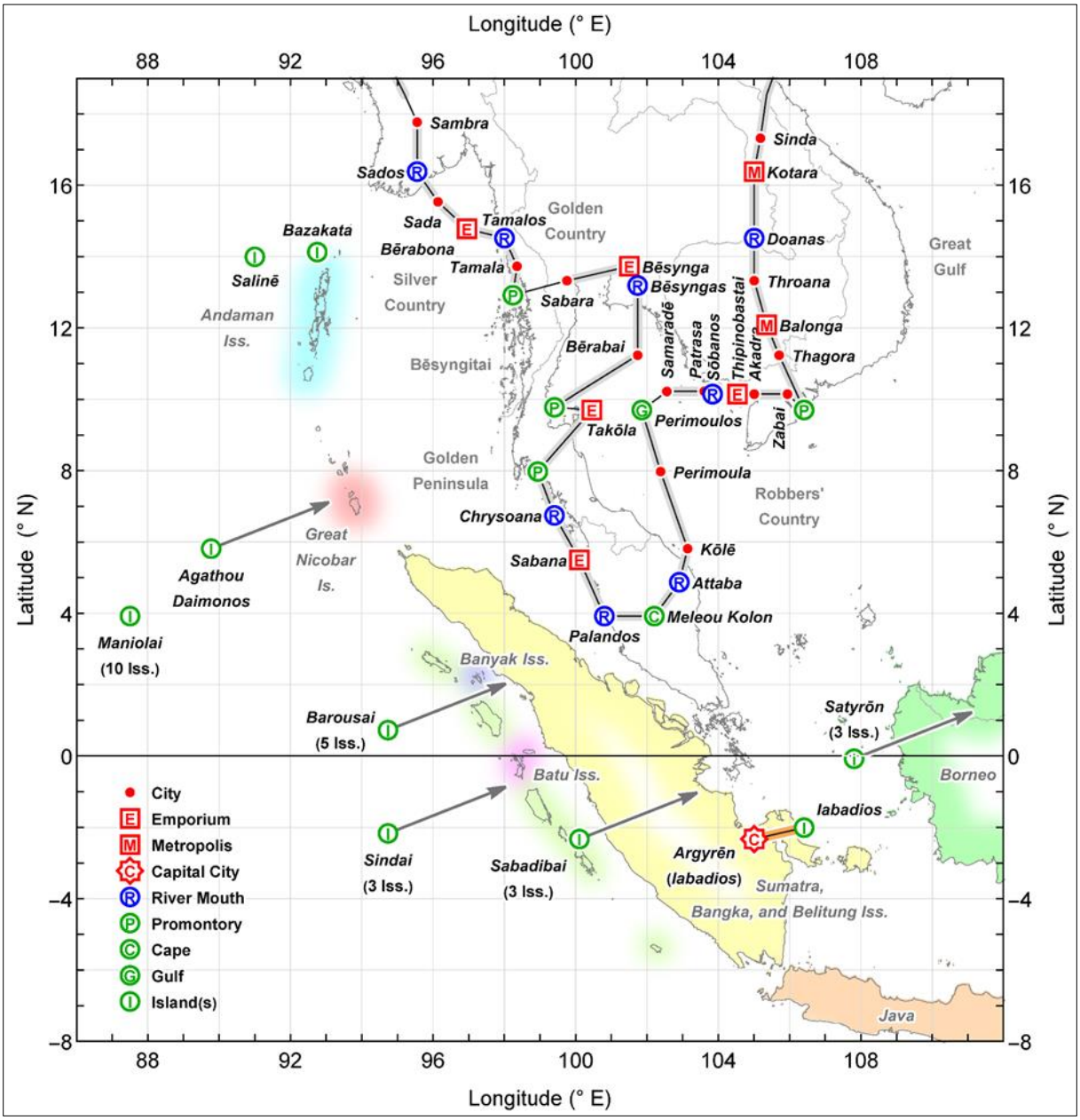

Figure 4: This map depicts the location of the Southeast Asian islands in the second century CE compared to modern maps. The geographical coordinates of some islands in Ptolemy's *Geography* contain a systematic error that can be adjusted by shifting the location to the northeast (grey arrows).

When comparing the geography that appears in Ptolemy's *Geography*, which is based on data supplied by Marinus of Tyre from the early second century CE, these data demonstrate the prevalence of maritime trade along the coast and across the Thai-Malay Peninsula (especially around the Kra Isthmus) that was in use more than 2000 years ago.

The Strait of Malacca is not mentioned in Ptolemy's *Geography*. However, the location and number of islands in the Andaman Archipelago, the Nicobar Islands, and Southeast Asian islands are accurately described. This description suggests that although there is no evidence to confirm that merchant ships usually sail from Sri Lanka to cross the Indian Ocean and reach Southeast Asia, the Greeks must have inherited geographical knowledge from the indigenous peoples. It demonstrates that these archipelago territories have been culturally Indianized since at least the second century BCE and that some of them have retained their former names until the present day.

The reinterpretation of Southeast Asia's geographical history through the eyes of Westerners may not be sufficient to confirm its full social dynamics. The continued use of Chinese records long after Ptolemy's *Geography* is equally important. Correctly geolocating the ancient states and geographical features of

Southeast Asia using multidisciplinary methods can be used to integrate the knowledge of Easterners with the knowledge gained from this study, thereby enriching future historical knowledge of the region.

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