



Some understandings and interpretations of the 1288 Bach Dang Victory from the geological-geomorphological and meteorological-hydrological perspectives

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Abstract:

The Bach Dang Victory in 1288 has been studied by many scientists, both domestic and international, for several decades from cultural, historical and archaeological perspectives, but not much on geological, meteorological-hydrological and paleo-environmental aspects. Based on existing data and results of recent investigations, this article gave a broader analysis on this historic victory, especially from a geological-geomorphological point of view, aiming at highlighting the tradition of using rivers and waterways of the Vietnamese people.

Key words: The Bach Dang Victory; geological; meteorological - hydrological.

JEL Classification: N95; P48; R11.

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1. INTRODUCTION

The 1288 Bach Dang Victory has been the subject of many studies, including interpretation on the natural characteristics and conditions of the area where the battle took place, mainly conducted by historians and archaeologists. There are only a few studies from the perspective of geology-geomorphology and meteorology-hydrology-oceanology. Whereas these characteristics have undergone many changes for 700 years both due to natural processes and human activities. Reconstructing them at the time of the battle is therefore challenging and inconsistent. Nevertheless, there is also some consensus, especially the Trần Dynasty's army and people's understanding, mastering, and fully exploiting the natural features and conditions to ensure the victory of battle. The article below reviews some current research results and interpretations from the geological-geomorphological and meteorological-hydrological-oceanographical perspective about this historical battle.

2. RESEARCH METHODS AND TECHNIQUES USED

Traditional methods and techniques of the natural and social sciences will be applied such as collecting, synthesizing, analyzing, processing existing documents, sociological investigation, surveying, mapping, analysis and processing data, and additional sample analysis...

Specialized research methods on tectonics - geomorphology, Meteorological and oceanographic and modern research methods such as analyzing remote sensing images, building databases...

3. RESEARCH RESULTS

3.1. Some research results and interpretations from the geological geomorphological and meteorological-hydrological-oceanographical perspectives

From the geological-geomorphological and meteorological-hydrological-oceanographical perspectives, there are basically research works of Nguyễn Ngọc Mến [12], Nguyễn Ngọc Thùy [13], and Trần Đức Thành [20]. In addition, it can be mentioned a few excavations and geophysical drills, measurements... in the framework of archaeological research tasks (Lê Thị Liên et al. [4, 5, 6, 7, 8], Sasaki et al. [17, 18]...). This specialized information is also mentioned in several other studies. For example, Nguyễn Việt et al. [20] made a number of suggestions to answer the question why the area at the intersection of Gia - Bach Dang - Chanh rivers was chosen by the Trần Dynasty as the place to ambush and intercept the Yuan army. Accordingly:

- Geologically, Coc Rapids is the determining factor of the topographic landscape here.

- The authors also agree with meteorological-hydrological-oceanographical scientists that the tidal range in the area is quite high, about 3m, higher or lower depending on the season. Waterway ambushes with the support of stake yards require high tidal ranges.

- The authors further pointed out that every estuary area has very complex and unrecognizable creeks that are always covered by mangroves, which is very convenient for ambush and creation of underwater stake yards. In addition, at that time, the Dong Trieu area from Pha Lai to Uong Bi was a forest rich in precious wood species.

According to Trần Đức Thành [20], the battle of Bach Dang was not limited to Bach Dang River and the mountains on both sides of the River. Not to mention some of the descriptions, for example on the tides, the depth of the riverbed, and the main stake battlefield... more than 700 years ago, are somehow different from today. The author made some comments as follow based on his analysis of archaeological documents on the Chanh River stake yard together with his and his colleagues' studies:

- *Regarding location and topographical characteristics*, the stake yard was on the left bank of the current Chanh River, in a low-lying field in Yen Giang Commune, on the old Chanh Riverbed. The changed position of the riverbed is a process of gradual movement to the South rather than a large sudden change.

- *Regarding stratigraphy*, the soil within the depth of 3m of the excavation pit is divided into 4 layers. The 0.5m thick top layer was accumulated at the development stage of the estuary under the condition of a low-tide or high-tide flat that has recently emerged above the average tide. Three blow layers were accumulated at the development stage of the delta estuarine. According to the author, the three top layers were formed after the Bach Dang battle in 1288.

- *Regarding the old tidal range and the protrusion of the stakes*, the depth from the old riverbed to the old mean tide level was only about 1.4m. However, this is probably not the deepest point of the river cross-section. Currently, in this area, the maximum tidal range is about 4m, and the average tide level is 2m higher than the lowest tide. If the sea level here in 1288 was 1.1m lower than today (compared to the mean tide level) and at that time the environment of Bach Dang estuary was a delta, it can be predicted that the tidal range was most likely 3m. If this prediction is correct, the old riverbed in the stake yard may be exposed when the tide is at its lowest and the stake yard at the deepest part of the riverbed may not have been discovered yet. Then, the stakes always protruded 0.6 - 0.9m above the old mean tide level and only at the high tide would they be completely flooded. Therefore, this was mainly a raised stake yard for camouflage, and Trần Hưng Đạo's army must have "covered grass on top" as stated in the Complete Annals of Dai Viet.

Regarding the highest and lowest tide level at midnight on the 8th and in daytime on the 9th of April 1288, which was 3.2m and 0.9m, respectively, [13] the author said that they were calculated based on the assumption that the topographical features and the tidal propagation conditions from the sea to the Bach Dang estuary have basically remained unchanged over the past 7 centuries while the topographical conditions and the structure of Bach Dang estuary have changed quite profoundly. Therefore, the tidal propagation conditions and the maximum tidal range were not the same as they are today. Nevertheless, tidal conditions then were a beneficial natural factor and successfully exploited.

Trần Đức Thành [20] attempted to reconstruct natural conditions of the Bach Dang battlefield in 1288. Accordingly, it lied at the center of Bach Dang estuary where was the transitional place between the Dong Trieu arc and the Red River - Thai Binh River Delta (Figure 1). Over 250km of coastline from the Vietnam - China border, this was the first estuary to have a waterway connecting with Thang Long citadel. Due to the location and transitional nature as well as its special shape and structure, Bach Dang estuary has a special position in terms of geopolitics and geo - military.



▲ Figure 1. Bach Dang estuary (Spot satellite image dated March 1st, 2008) (Trần Đức Thành [20])



- *Regarding geological structure*, Bach Dang estuary is funnel - shaped, formed as a result of the interaction between a neo - tectonic collapsing graben and the eustatic sea level rise, the lack of sediment and the large tidal range, shielded by Cat Ba archipelago in the East and Do Son peninsula in the West, so it has a semi - enclosed form, relatively separated from the sea and only connected to the sea in the South and underground at a depth of 6m.

- *Regarding formation and evolution process*, Bach Dang estuary in the Holocene (from 11.7 Ka to today) went through three periods and six stages including [19, 35, 36] (For more details, please the article in this specialized journal):

+ *First period*: Early-Middle Holocene (11.7 - 2.5 Ka.). The post-Last Glacial Maximum transgression caused flooding and changed the environment from the mainland to the nearshore one. At the end of this period, the sea level rose slowly, the sea receded.

+ *Second period*: Late Holocene (2.5 Ka. to 700 - 500 years ago). Late Holocene transgression began and ended soon after that.

+ *Third period*: Late Late Holocene (about 700 - 500 years ago to the present), consisting of only one period, the modern transgression.

- *Regarding topographical morphology*, Bach Dang estuary is also distinctive from the area along the banks of the Red River Delta, including tidal marshes with dense natural mangrove vegetation, tidal creek system, dense tidal channel, tidal sandbars along the channel shores, abrasive terraces developing in the low-tide zone on the loose sediment basis... [20].

- *Regarding hydrology - oceanography*, due to the semi - enclosed structure, the waves were generally not strong, except during storms. The eustatic sea level about a thousand years ago was approximately 1m lower than today, and during the war in 1288 it could be about 0.5m lower than today. Meanwhile, the current tidal range is larger than that of thousands of years ago. Perhaps the diurnal tide regime and the law of tidal oscillation according to the lunar calendar were not different from today, but the tidal magnitude during the war in 1288 might be about 0.2 - 0.5m less than today [20].

- *Regarding climate*, the estuary was in the tropical monsoon area. In the summer, it was hot and humid. It rained a lot in May - August, which coincided with the season of the Southwest monsoon blowing in the prevailing East and Southeast directions, and storms and tropical depressions often occurred. The rest of the year coincided with the Northeast monsoon season in which the North and Northeast winds prevailed in September - November and the East winds prevailed in December - April, often accompanied by cold, wet, and rainy weather, drizzle and fog, very low visibility, some times down to a few meters, causing many difficulties to traffic [20]. According to the author, in addition to

the role of tides that was reasonably fully applied to ensure a successful battle, other factors, especially flows and winds, though mostly unreported, certainly played an important part.

- *Regarding ecosystem*, the characteristics of an estuarine ecosystem are different from those of delta estuary, such as better mixing of river-sea water, higher salinity, stable biomes, and higher biodiversity. Mangroves had two typical plant populations: *Đước* (*Rhizophora stylosa* Griff), *vẹt* (*Bruguiera gymnorhiza*) in brackish - salt water and *bần chua* (*Sonneratia caseolaris*) in brackish - fresh waters [20].

In brief, located at the Northeastern edge of the modern Red River Delta, Bach Dang estuary has a typical estuary structure and is relatively independent of the modern Red River Delta estuary. But about 700 - 500 years ago, it was still a part of the Red River Delta and had an accretionary shore extended further out into the sea than it is today [20]. In this context, the naval battle of Bach Dang in 1288 happened in the brackish-fresh water delta environment, not a saltwater and brackish - salt estuary with a shallower and narrower river like today. The dominant plant community at that time were hardy sugar canes (*Saccharum arundinaceum*), reeds (*Phragmites*) and mangrove apples (*Sonneratia caseolaris*), often growing in swamps, freshwater or rather brackish flood lands, not belonging to the group of mangroves, red mangroves (*Rhizophora stylosa* Griff), and mangrove apples (*Sonneratia caseolaris*) like nowadays. Many natural features and conditions of Bach Dang estuary have been preserved since then while many other factors have changed such as the topography, and the forest ecosystem has also significantly transformed. Overall, many natural features and conditions were fully utilized and significantly contributed to the victory of the battle [20].

3.2. A few more contributions from a geological-geomorphological perspective

The geological - geomorphological descriptions and interpretations in the few works mentioned above still have some differences. Therefore, the following section, along with additional comments and comments, reviews some key geological - geomorphological features of the Bach Dang battlefield as well as the wider surrounding area:

3.2.1. Stratigraphy

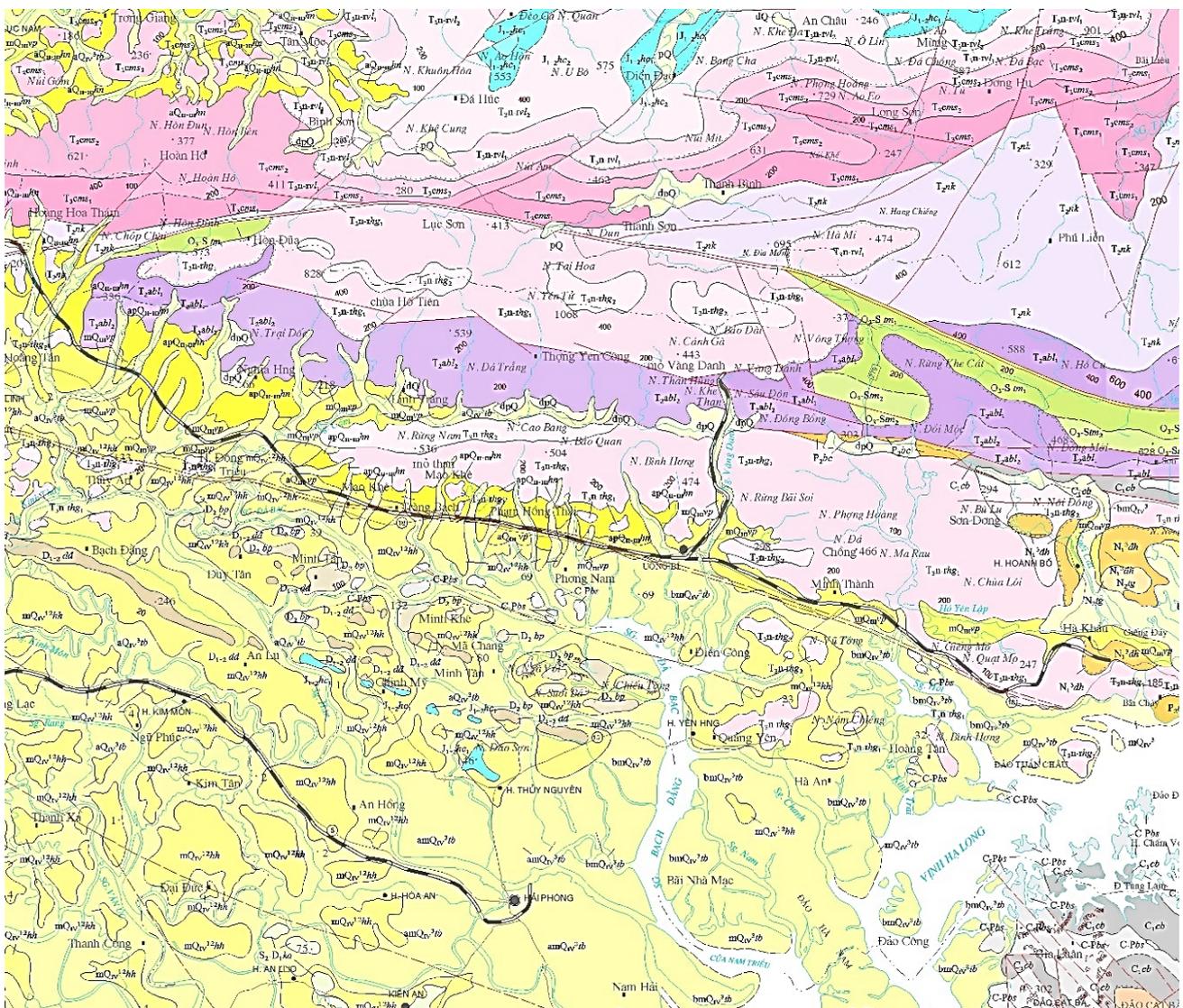
In Bach Dang estuary in particular and Dong Trieu arc in general, there are soil and rock of different ages from ancient to young as follows: Song Cau series (D_{1sc}), Duong Dong formation (D_{1-2dd}), Trang Kenh formation (D_{2-3tk}), Ba Son formation (C-Pbs), Hon Gai formation (T_{3n-rhg}), Ha Coi formation (J_{1-2hc}), and Quaternary loose sediments (Hanoi formation (Q_1^{2-3hn}), Vinh Phuc formation (Q_1^{3vp}), Hai Hung formation (Q_2^{1-2hh}), and Thai Binh formation (Q_2^{3tb})). Details of these geological units have been introduced in another studies [2, 9, 10, 19]. This section just reiterates a few notable points as follows:

- The Duong Dong, Trang Kenh, and Bac Son formations are exposed in small peaks mainly in the South of Kinh Thay - Da Bac River, slightly extending in the sub-latitude or the West - Northwest (WNW)

- East - Southeast (ESE) direction. The terrigenous rocks of the Duong Dong formation formed lowland hills and mountains; the Trang Kenh and Bac Son formations formed the towering relict karst aiguilles with the same height. Similarly in the same structural direction are the small outcrops extending the cobblestone, gritstone, and sandstone of the Ha Coi formation, exposed mainly to the South of Gia River.

- The exposed terrigenous rocks of the Hon Gai formation are mainly in Yen Tu range, North of Uong Bi City center. There are two other remarkable outcrops: On the left bank of Bach Dang River, the area of Tien mountain and Vu Tuong mountain of Quang Yen Town (Quang Ninh Province); Some smaller outcrops along Kinh Thay River in Chi Linh Town (Hai Duong Province).

- Regarding Quaternary friable sediments: The Hanoi formation (apQ_1^{2-3hn}); The Vinh Phuc formation (amQ_1^{3vp}); The Hai Hung formation (mQ_2^{1-2hh}) and The Thai Binh formation (a, m, am, bm Q_2^{3tb}).



▲ Figure 2. 1/200,000 geological map of Bach Dang River and surrounding area [2]



3.2.2. Tectonic context and geological structure

The study area is the lower part of the Dong Trieu arc with tectonic context and geological structural features that are similar to and closely related with the Dong Trieu arc. The most prominent in this area is the deep fault zone of Road 18 in the sub - latitude direction slightly towards the WNW - ESE (about 90 - 110°). Along this deep fault zone, the Northern wing (Yen Tu Mountain range) is relatively higher than the Southern wing.

During the Neotectonic period, it also developed quite widely throughout the sub-meridian fault system, forming a series of small rivers that cut the Yen Tu mountain range such as Uong River, Sinh River, and Bi River..., especially Bach Dang River - the extension of the Uong River - Sinh River faults (Da Bac River, meeting this sub - meridian fault zone while flowing to Dien Cong area, had to divert towards the South).

Other fault systems, including the relatively developed Northwest (NW) - Southeast (SE) about 330°, and the less developed Northeast (NE) - Southwest (SW) about 70°, also resulted in some river sections flowing along them, such as the beginning parts of Gia River, Bi River, or Hang Ma River... (NW - SE direction), or sections of Duong River, Da Vach River, the short section connecting Kinh Thay River with Da Bac River at Dun confluence (Lai Xuan ferry wharf)...

The activities of sub - latitude faults and WNW - ESE faults controlled the distribution of Paleozoic and Mesozoic sedimentary rocks as well as dissected them into small bands extending in the same direction.

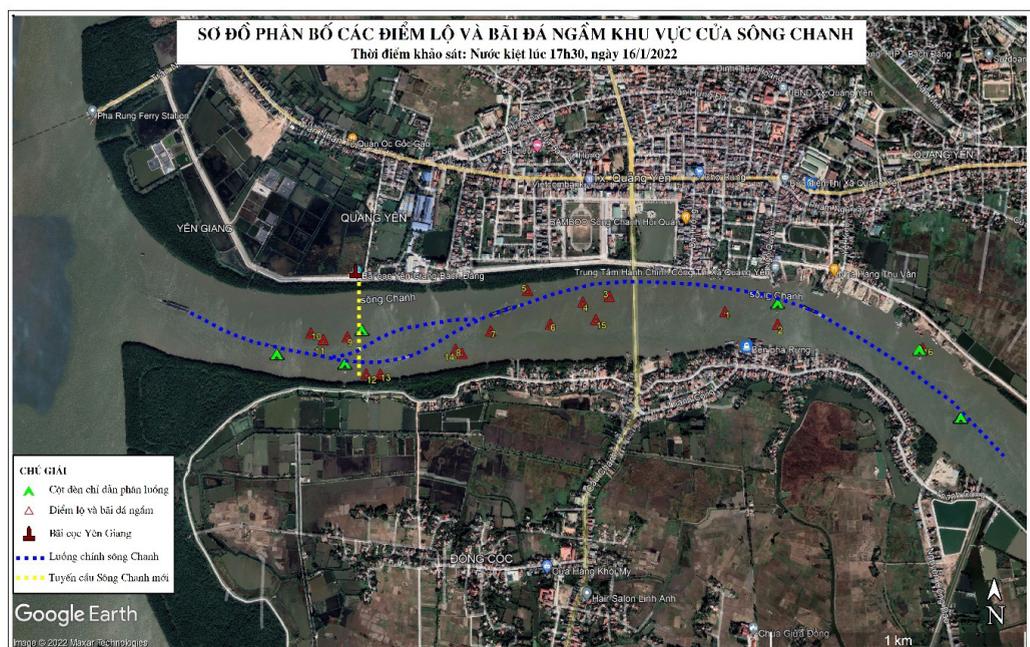
The Bach Dang River sub - meridian fault (and extending further north, possibly along Uong River or Sinh River) is also noteworthy. It creates a differ-

ence in the distribution of ancient rock and soil on both sides of the fault, specifically the Hon Gai formation (T_{3n-rhg}) (area of Tien mountain, Vu Tuong mountain) on the left, contrary to Duong Dong, Trang Kenh, Bac Son, and Ha Coi formations (without Hon Gai formation) on the right. Perhaps this fault has played a controlling role from the formation of the Hon Gai formation sedimentary basin, with the left wing relatively lower than the right wing, causing the Paleozoic rock formations on that side to plunge quite deeply, and all were only relatively uplifted in the modern tectonic period.

The existence of the Gia River - Chanh River fault in the sub - latitude to WNW - ESE direction and the small ancient rock outcrops in the same direction as well as the activity of the Bach Dang River sub - meridian fault as presented above can explain the existence of Coc Rapids, Chanh Rapids as well as the mounds on Ha Nam Island, including those that have been described as conglomerates and gritstone of the Ha Coi formation ($J_{1-2}hc$) [6,20], and at the same time explain the above-mentioned researchers' comments [2, 9, 10].

The authors of this article have recently surveyed using a small boat along the river section from the (old) Chanh River bridge to the confluence of the Bach Dang River, collected, and petrographically analyzed some geological samples taken from boreholes of Chanh River bridge pillar, thereby drawing some of the following observations:

- Based on the samples that are believed to be lime clay intercalation in siltstone sand, they were most likely of the Ha Coi formation. However, the detail cited in descriptions about the geological characteristics of the Chanh Rapids [3] that it developed and blocked Chanh River in the NE - SW direction, is unlikely. It's



▲ Figure 3. Distribution diagram of outcrops and reefs in Chanh River estuary (surveyed at 05:30 p.m. on January 16th, 2022, at low tide)



simply because the structural direction of the soil and rock in this area is mainly sub - latitude to WNW - ESE. Similarly, the description on Coc Rapids [12] may be reasonable, but the 110° angle is not consistent with the mentioned general structural direction.

- Along the above-mentioned section of Chanh River, dozens of bedrock outcrops float above the River surface during dead tide, and very shallow bedrock, just over 1m, is exposed in many large areas of the riverbed. At dead tide, ships passing through this river section can only navigate in a single fixed channel. Compared with the topographic and hydrographic conditions of more than 700 years ago, this detail shows that at dead tide, in the battle context, and especially for large ships, it is simply impossible to cross the Chanh Rapids (as today). Most likely, the channel of the Chanh River (on which ships could circulate) at that time had to be a little too North and was blocked by the Trần army and people using stakes (Yen Giang stake yard) (Figure 3).

- Together, Coc Rapids, Chanh Rapids as well as the mounds along the Chanh River, Ha Nam island... can be considered as a large bedrock area (some hidden, some exposed), an extension of the Ha Coi Formation ($J_{1-2}hc$) from the right bank - from Yen Phu mountain range (now in Kinh Mon Town, Hai Duong Province) - but has been lowered slightly on the left bank of Bach Dang River, making the last natural barricade of the historic battle of Bach Dang.

3.2.3. Geomorphological features and topographic morphology

One of the unique features of the Bach Dang battlefield is the old karst - non - karst landscape in Duong Nham - Nham Duong - Truc Dong - Trang Kenh strip in Kinh Mon Town and Thuy Nguyen District, basically bordering Kinh Thay - Da Vach - Da Bac River sections to the North and Gia River to the South extending backwards to the Northwest. The old karst landscape has created a system of large and wide caves, mainly developed horizontally. Subsequent transgressions-regressions have expanded these caves and additionally formed a system of tunnel caves, underground cave rivers, closed water and lakes, and interlaced canals that the army and people of the Trần Dynasty fully utilized for the Bach Dang campaign.

Another unique feature in the topographic morphology at the end of Bach Dang River, specifically on Ha Nam Island, which have been mentioned by some historians, archaeologists, and geologists in historical literature or excavation results and may have been erased by human activities, is the system of ancient flows interlaced between mounds and sandbars... in 1288:

- Many author [3, 5, 4, 20...] identified many ancient mounds and sandbars when describing and commenting on Vua Ba shrine, Tran Hung Dao temple, and the Yen Giang, Dong Van Muoi, and Dong Ma Ngua stake yards. A series of communal houses and temples, including populated areas on Ha Nam Island, is also de-

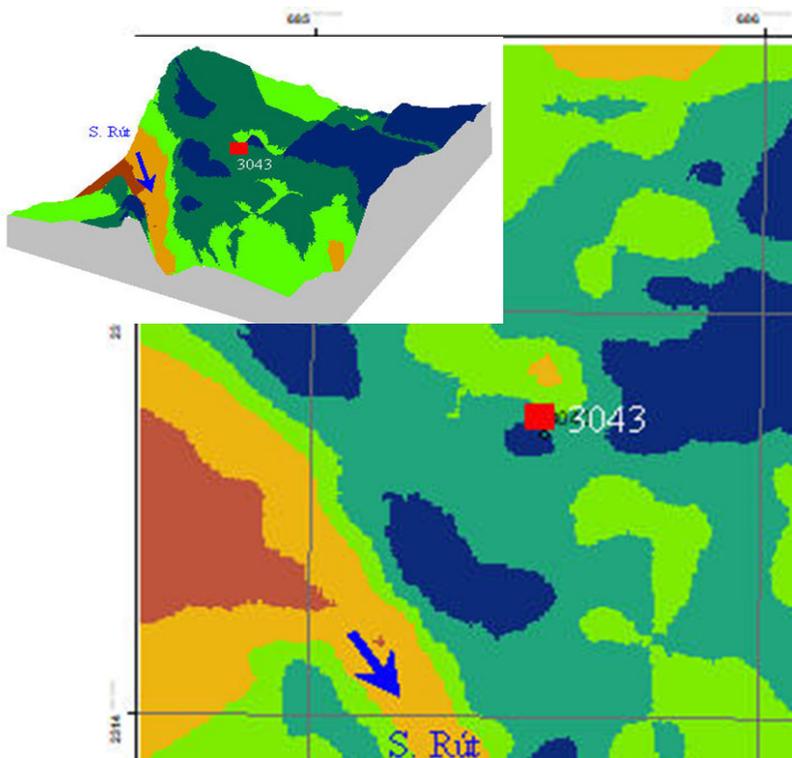
scribed as being on high lands that may have fresh water.

- Most of authors believe that the flows have greatly changed, especially since the dyke system was built around Ha Nam Island, and that when the battle occurred in 1288, the Chanh and Rut Rivers were not even named, not to mention Kenh River; the Bach Dang Riverbed was very wide at the time, some main flows have narrowed now, and some minor flows such as Kenh River and its tributaries have disappeared; that the network of ancient flows was complicatedly distributed, weaving between the soil bars and rock mounds; that drilling results show traces of currents in many places, ancient riverbeds, even the “umbilicus” of ancient flows where artifacts drifted to and accumulated. On the contrary, another opinion [20] when referring to Yen Giang stake yard noted that in 1288 the flows in this area were much narrower and shallower than today.

There has not been any research that convincingly depicts the morphological characteristics of the Bach Dang River - Chanh River - Rut River - Kenh River system... in this downstream section. Aggregating the analyses and interpretations above and comparing them with recent investigations and results, the authors of this article suggested that above description of archaeologists and historians may only be exact at spring tide, but at low tide it was still an interlaced system of clear-banked currents, shallower and smaller than today. The sediment load was very large in the context of a delta, regression, and the sea level was about 1.0m lower than today... In the context of a delta river system approaching the sea, it is precisely a “braided river” or “horsetail braided channel” with many small, braided streams weaving between mounds and sand bars... However, the “braided” flow system in the downstream part of Bach Dang River had some differences as follows:

- Although it was a large delta river system, its development space was controlled by fault zones and bedrock outcrops, as described above.

- Although it was a “braided” river system, a majority of islands and mounds in the middle of the stream were made up of bedrock. However, due to the large alluvial load, it still formed some bars and mounds composed of coarse - grained alluvium.



▲ Figure 4. Topography of Dong Van Muoi stake yard extracted from Google Earth images, clearly showing the location of some surrounding mounds (dark green) [21]

These mounds and sandbars, along with the creeks weaving between them as well as their two banks, if composed of alluvium instead of bedrock, also often changed their morphologies.

- More importantly, the entire area was still under the strong influence of the diurnal tide; the above-mentioned mounds, bars, and banks of the creeks were only exposed at low tide and still significantly obscured at spring tide, became “part” (but shallow) of the “expanded” Bach Dang River. Bach Dang River could become very wide but included fairly deep “real” creeks and other shallower parts.

Some interpretations drawn from the above characteristics are:

- Could the shifting of Chanh Riverbed assumed by Trần Đức Thành [20] occur? The authors of this article believed that this assumption does not necessarily happen. According to the descriptions of Gan Xuong mound [3], it was one or a series of midstream sandbar(s) - the center of the Bach Dang battle. In other words, both flows or two parts of the same flow, were already in existence - Chanh River - separated by one or a series of midstream sandbar(s). The Northern half of it was blocked by the Yen Giang stake yard, while the Southern half was shallow as described above.

- Two possibilities were pointed out by Trần Đức Thành [20]: The main axis of Bach Dang River did not change, but later the riverbed was widened and deepened; The main axis of the River has shifted hundreds of meters and only revealed Coc Rapids later. The first

possibility is more reasonable. It is most likely that the right bank of “Gan Xuong mound” - the ancient midstream sandbar mentioned above - both at spring tide and at neap tide, as being blocked by Coc Rapids, was diverted to the left bank, partly flowing into Chanh River and partly towards Rut River (where Coc Rapids was interrupted by the sub-meridian fault, resulting a slit in Bach Dang Riverbed which was narrow (only 6m wide) but deep).

- It is entirely possible that at that time, even though there existed the downstream section of Bach Dang River flowing to Nam Trieu estuary, Chanh River flowing into Lach Huyen estuary was still very important and remained a prioritized waterway route. However, the trend of gradually shifting the main estuary from Lach Huyen to Nam Trieu is still irreversible in the general fluctuation picture of the entire Red River - Thai Binh River system.

- Chanh River and Rut River might then be “component” flows of Bach Dang River but had not been named. Therefore, Bach Dang River, as described and currently understood as the current Bach Dang River, could be a collection of rivers, including Bach Dang, Chanh, Rut, and Kenh... The ability to “intercept the battleships” was probable, but that was of “the expanded Bach Dang River” (but shrunk naturally by rock rapids) as well as shallow water spaces among them.

- The ability to confront [14, 15] a fleet of hundreds of enemy ships perhaps would be possible if there were both natural and artificial “barriers”. Because enemy ships were bigger, stronger, more solid and, at the same time, had a great advantage downstream with the receding tide, nothing could stop them without these “barriers”.

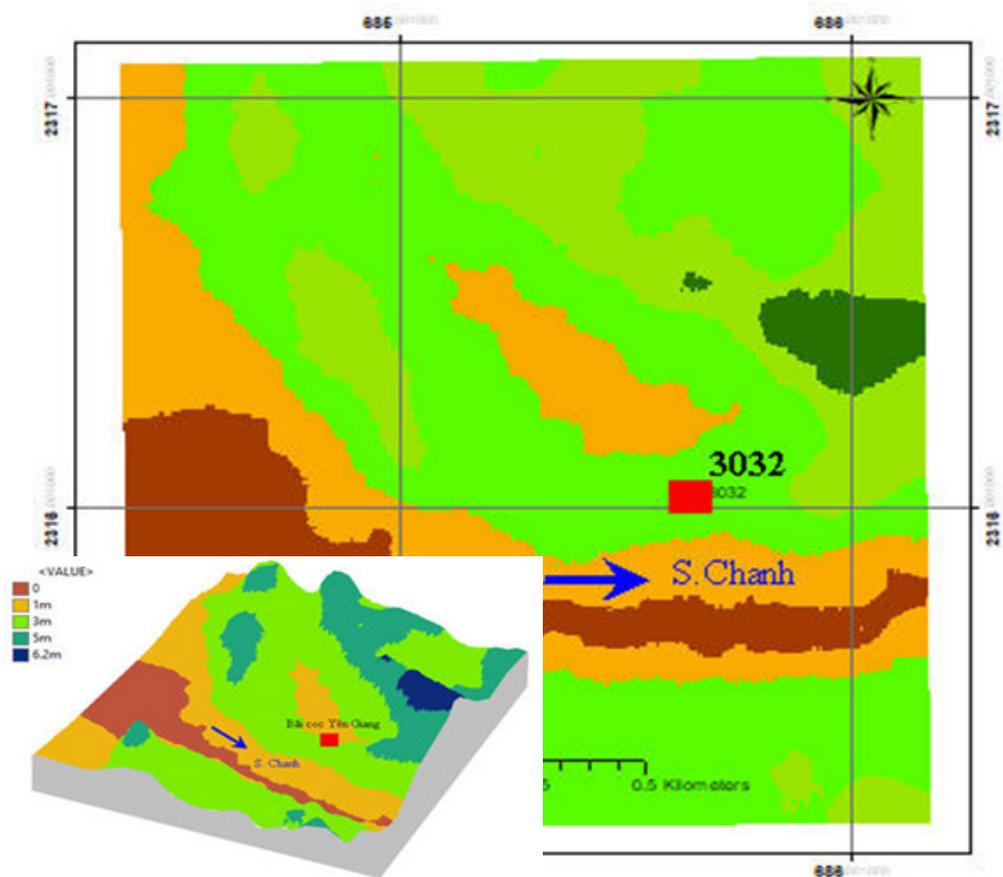
- Therefore, the argument on the possibility of another stake yard, along with Coc Rapids, blocking the Bach Dang River [20] is probably more reasonable. This river was not wide and deep (as it is now) and the flow was slightly inclined to the left bank towards Rut River, focusing on the place that is now a deep but narrow creek (only about 6m wide), so the staking as well as blocking the enemy’s warships was not too difficult as in the case of today’s deep and wide Bach Dang River.

- As mentioned above, at high tide, Bach ang River expanded to include “true” creeks, mounds, sandbars, and shallow water areas that might be completely exposed or remained swamps at dead tide. In the naval battle ambush of the Trần Dynasty army and people, in addition to the “real” creeks with stakes or protected by underground rapids and emerged mounds and sandbars ambushed and captured by the Trần army and people, the shallows mentioned above surprisingly played an important role - they became waterways for boats, including the smaller warships of the Trần army, to move between the upstream and the downstream, the stake yards and rapids while preventing the enemy ships, which were larger and heavier, from retreating. Possibly not all the shallows would be left vacant for boat traffic. A part of their cross - sections could also be staked to narrow and limit the ability of enemy ships to flee. In that case, unlike the “real” creeks where large and deep stakes were required, perhaps only smaller, shorter, and “denser” stakes in the form of a “citadel” as seen in Dong Ma Ngua stake yard were appropriate.

3.2.4. Tide levels and flow depths

Information obtained from existing studies on tide levels and flow depths, and thereby some other relevant information such as stake length, staking depth..., is also quite different [3, 8, 12, 13, 16, 20...]. Below are some inferences of the authors of this article:

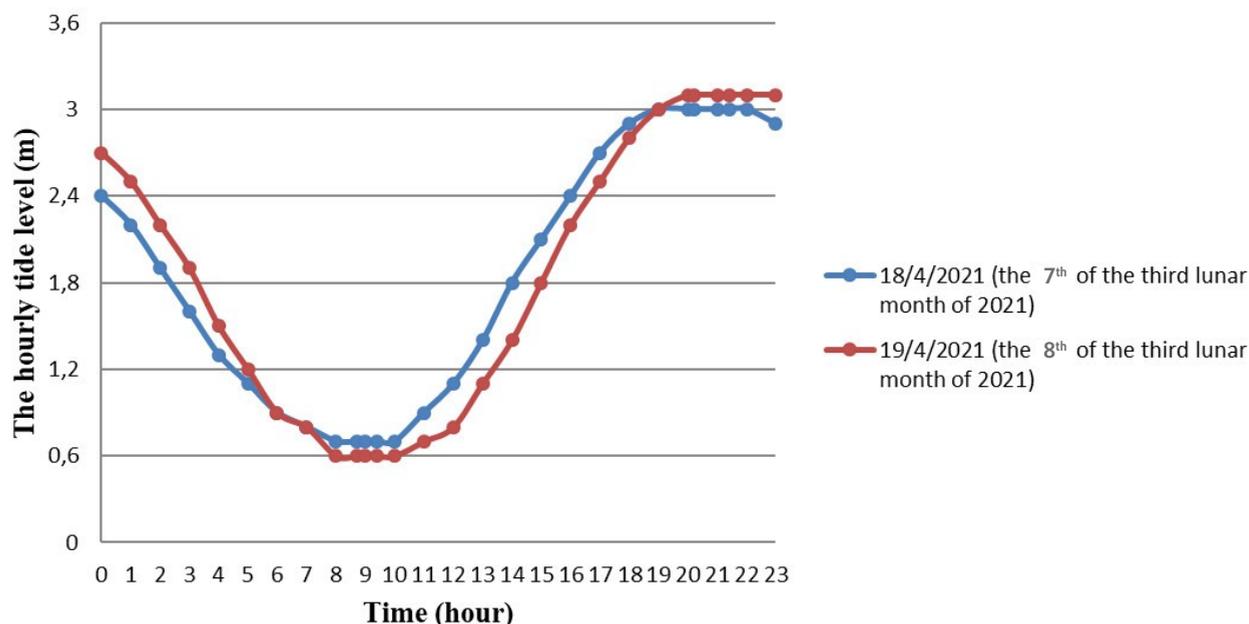
- Assuming the sea level then was about 1.0 - 1.5m lower than now but the difference between spring tide/dead tide on April 9th, 1288 (8th of the third lunar month) was still 3.0m.
- Assuming the draft of the Yuan army’s ships was 2.5m [15].
- Assuming the stakes were driven at around dead tide about 1.0m or a little more above the low tide level (so that in spring tide, the stakes would be submerged



▲ Figure 5. Topography of Yen Giang stake yard extracted from Google Earth images, clearly showing the possible traces of an ancient flow just Northwest of the stake yard (orange) [21]

about 2.0m or less, which could block ships of the Yuan army with a draft of 2.5m and definitely it was able to stop enemy ships when the tide was receding until the dead tide at noon). If the stakes were 1m higher than the dead tide, it would be more difficult to drive, and they must be longer. The stakes were assumed to be about 3.0m long (about 1.0m in the riverbed, 1.0m (or less) in the water and 1.0m above the water (at dead tide, or a little more to ensure just 2.0m or less low than the spring tide level)).

- Assuming the ground was only equal to the dead tide level and would be flooded at 3m high tide. If that was the case, without the stakes, the Yuan ships could have gone anywhere at spring tide. So, it is more likely that the ground, for example in Ha Nam Island area, would then be higher than the dead tide level (emerging above the water surface at least about 0.5m) so that at spring tide it was flooded about 2.5m. The mounds could be higher, for example about 1.0m higher, to be submerged about 1-2m or less, even some places could emerge above the water surface even in spring tide. Then large battleships of

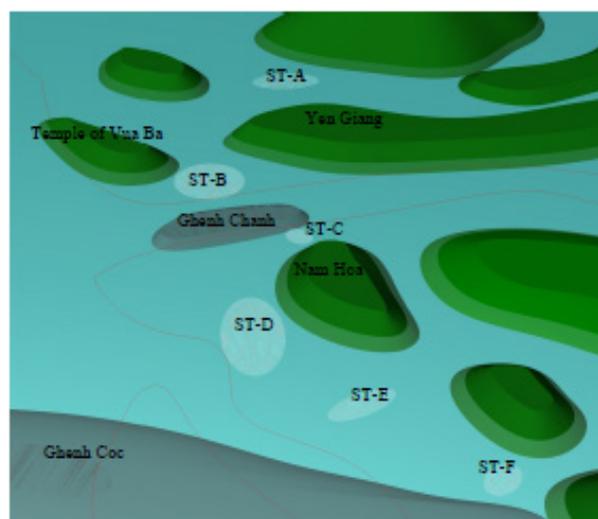
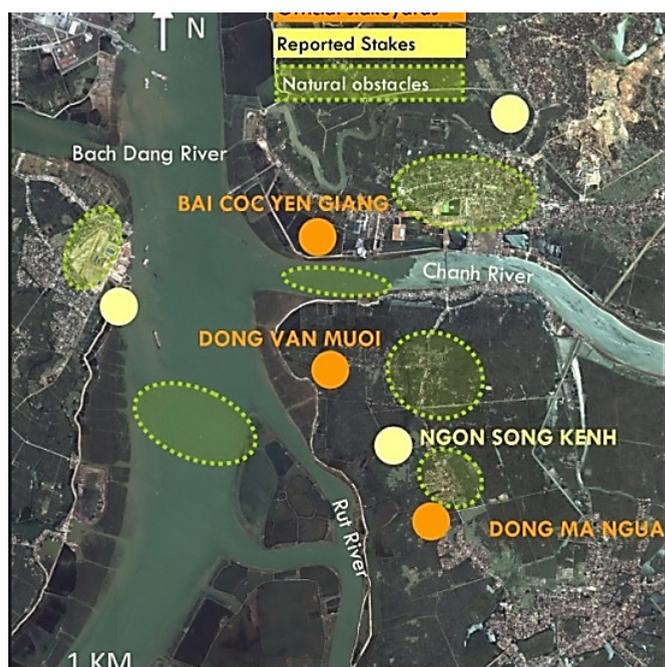


▲ Figure 6. Illustration of the tide level changes on the 18th and 19th April 2021 (according to data from Hon Dau station), in particular the high tide in the early morning on the 19th is about 3m, the low tide on the same day is about 0.5m, the tidal difference is about 2.5m

the Yuan army would run aground while small ships of the Trần army could still travel. Such places did not require staking.

- For the creeks, assuming that in dead tide, ships, including warships of the Yuan army, could still navigate, then the riverbed must have been at least 2.5m lower than the dead tide level, that is, about 5.5 meters lower than the spring tide level. Driving the stakes to the bottom of the creeks at that time was not easy, people had to wait until the dead tide, and had to keep the stakes about 1.0m higher than the dead tide level. Assuming that the stakes were driven into the riverbed to the depth of 1.0m, the minimum length of the stakes

must be about 4.5m - which was too long and difficult to arrange. However, the staking was still required, and suitable wood still had to be found, but with limited number. Therefore, the role of Coc and Chanh rapids was even more important in that they had significantly narrowed the beds of Bach Dang River or Chanh River, Rut River, and Kenh River... And because they were placed on the stream, right after the Victory, perhaps the Trần army and people removed them to enable traffic on Van Don - Thang Long waterway.



▲ Figure 7. Conceptual arrangement of stake yards and obstacles on the Bach Dang battlefield (Randall S. 2009) [29]



- What stakes yards did the Trần army and people leave behind (forget)? After the above-mentioned mid-stream stake yards had been removed, the stream edges where the riverbed was a bit shallower may have had stakes which were left behind (forgotten) after the battle (boats could pass through these places (lower than the ground but higher than the riverbed at its deepest) when the tide was rising (not yet at its maximum) or receding (not yet at its minimum). These stakes were submerged at high tide and slightly exposed at dead tide, and generally had little impact on daily life. They could also be slightly shorter, for example about 2.5 - 3.0m long.

- Thus, assuming these remaining stakes were about 1.0m higher than the dead tide level at that time, about 2.0m lower than the high tide level at that time, and area now buried 1.5 - 2.5m underground, it means that the ground of the stake yard is now almost equal to the high tide level at that time (only about 0.5m lower), 2.5m higher than the dead tide level at that time, and 3.5m higher than the riverbed at that time. In other words, today's ground is about 1.5 - 2.0m higher than the ground at that time (or less for the mounds at that time). Therefore, the possibility of finding traces of the old mounds is low (without drilling and excavation). Besides, the sedimentation rate is remarkable, about 1.5 - 2.0, even 3.5m within nearly 700 years, including 500 years in which transgression and washout prevailed. If so, the sedimentation rate must have been faster in the last 200 - 300 years of regression at that time.

- The discovery of an oar, pieces of coal, and a layer of black mud with high organic matter content in Dong Ma Ngua stake yard (Lê Thị Liên et al. [15]) shows that this could have been the area of fierce fighting as recorded in the legend of Tau Chim (shipwreck) mound and the local proverb "Bach Dang River is the frontier river/ Tong Ha Nam is the battlefield". A close combat occurred when the tide was still low, and Ha Nam Island was like a swamp. Enemy ships were blocked from moving back and forth and additionally attacked by fire, some ran into the stake yard, some crashed into each other..., the Yuan Mong army must have rushed to the Ha Nam peninsula to escape. Certainly, the Trần army and people had surrounded and only left them a way to run into Ha Nam peninsula. The Trần army and people at that time were still able to ride light boats or ambushed on the mounds to destroy them.

4. CONCLUSIONS

Based on analysis and aggregation of existing documents and additional investigations, surveys, and studies, mainly from a geological - geomorphological perspective, the authors of this article have once again attempted to reconstruct the natural characteristics and conditions of the Bach Dang battlefield area in 1288 and come to the following conclusions:

- As a part of the Dong Trieu arc and used to be the most important waterway of Dai Viet, the Duong - Kinh

Thay - Bach Dang River system in 1288 was still one of the two most important waterways of the country (along with the Red River system and its tributaries), and it is still an important waterway of the North-eastern of Vietnam. Since ancient times, perhaps at least since the time of Ha Long Culture, the Vietnamese have had a tradition of exploiting and using this river system as part of the tradition of exploiting and using the Dong Trieu arc in all aspects of life, including in the resistance wars against foreign invaders.

- In terms of geology - geomorphology, the Kinh Thay - Da Bac - Bach Dang River system has formed and developed for at least hundreds of thousands of years and often follows the sub-latitude (WNW - ESE) axis belonging to the Road 18 deep fault system. In the past, this river section used to flow basically in this direction but slightly shifted northward; along this strip are Chi Linh - Dong Trieu - Mao Khe - Uong Bi urban centers. The uplift process of Yen Tu range (in the Dong Trieu arc) and relative recession of the Southern flank of Road 18 deep fault have caused these rivers to gradually move down to their present position. Similarly, the Gia River - Chanh River fault also exhibits an uplift in the Northern flank and a recession on the Southern flank with small outcrops of sediments of the Ha Coi formation ($J_{1-2}hc$) having tectonic relation with the sediments of the Duong Dong formation ($D_{1-2}dd$) on the right bank of Bach Dang River, and the mounds of Ha Nam Island are relatively submerged as compared to the sediments of the Hon Gai formation (T_3n-rhg) on the left bank of Chanh River.

- The development of the sub - meridian fault system has divided Yen Tu mountain range into a number of blocks with relatively different uplift and recession amplitudes. Da Bac River flowing here had to change to the sub - meridian direction to become Bach Dang River. One of the obvious consequences is the current Yen Tu block (with Yen Tu peak with an altitude of 1,068 m asl), while Bao Dai block is only about 875m high. Similarly, on the right bank of Bach Dang River, only rocks of up to Permo - Carboniferous are exposed (excluding some small outcrops of the Ha Coi formation of Jurassic age of river, lake, and swamp origin), while on the left bank exposed mainly Triassic terrigenous rocks of the Hon Gai formation (T_3n-rhg).



- The consequence of the above faulting activities is that the bedrock in Ha Nam Island has been generally submerged compared to the bedrock on the right bank of Bach Dang River and left bank of Chanh River, and slightly exposed in the form of low mounds above the tidal level.

- As a part of the Hong River - Thai Binh River Delta, the downstream section of Bach Dang River in 1288 had the typical morphological characteristics of a “braided river” with interlaced streams and creeks interspersed between mounds, sandbars,... both permanent and temporary, thus it frequently changed, especially under the significant influence of the tidal regime. The creeks showed clear shorelines at low tide and in places between bedrock mounds and firmly attached ancient sandbars. The stream was considerably widened at high tide and in places where it was interspersed with temporary banks composed of weak sandy mud, but it was possible to distinguish between the “real” deep creeks and the “temporary” shallower flows. Along with the mounds, sandbars, rapids, and the system of stake yards, these “temporary” flow sections also played an important role in the battle of Bach Dang in 1288 in preventing the Yuan ships while still allowing the Dai Viet boats and ships to travel easily ■

REFERENCES

1. *Complete Annals of Đại Việt, volume II. Social Science Publishing House, Hanoi, 1998.*
2. Hoàng Ngọc Kỳ, 1999. *Geological and Mineral map, scale 1/200,000 Hai Phong sheet, F48-XXIX. General Department of Geology and Minerals of Vietnam, Hanoi.*
3. Lê Đông Sơn, 2009. *Bach Dang Victory in 1288, relics, and legends. National Political Publishing House.*
4. Le L.T., Nguyen H.T.M., Pham C., Staniforth M., Delgado J.P., Kimura J., Sasaki R., 2011. *Understanding the Bach Dang battlefield from recent research results, in M. Staniforth, J. Craig, C. Jago-on, Kimura J., Proceedings of the Asia-Pacific Regional Conference on Underwater Cultural Heritage. Asian Academy for Heritage Management. Manila, Philippines, pp. 77 - 90.*
5. Lê Thị Liên, 2010. *Bach Dang battlefield - New insights from Dong Van Muoi and Dong Ma Ngua (Nam Hoa Commune, Yen Hung District, Quang Ninh)). Archives of Institute of Archeology. Hanoi.*
6. Lê Thị Liên, Nguyễn Thị Mai Hương and international research group, 2009. *Summary report on survey results of Bach Dang relic site in February - March 2009. Archives of Institute of Archeology.*
7. Lê Thị Liên, Nguyễn Thị Mai Hương, 2011. *Report on excavation of Dong Ma Ngua relic site (Yen Hung District, Quang Ninh Province) 2010. Archives of Institute of Archeology.*
8. Lê Thị Liên, Pham C. and Pollack J.C., 2009. *The Bach Dang battlefield in 1288 C.E. - Previous Excavations and Research. Paper presented at the Society for Historical Archaeology (SHA) Conference in Austin, Texas, USA.*
9. Nguyễn Công Lương, 1999. *Geological and Mineral map, scale 1/200,000 Mong Cai sheet, F48-XXIV. General Department of Geology and Minerals of Vietnam.*
10. Nguyễn Công Lương, 1999. *Geological and Mineral map, scale 1/200,000 Ha Long (Hon Gai) sheet, F48-XXXV. General Department of Geology and Minerals of Vietnam.*
11. Nguyễn Đức Tâm, 2011, *On the current climate change issue. Journal of Geology, series A, No. 326, 7 - 8/2011, pp. 1 - 16.*
12. Nguyễn Ngọc Mến, 1988. *Paleogeomorphology of Bach Dang battlefield in 1288. Scientific conference to celebrate the 700th anniversary of Bach Dang Victory (1288 - 1988).*
13. Nguyễn Ngọc Thúy, 1964. *About the tide in the battle of Bach Dang in 1288. Historical Research, No. 63, 6 - 1964, pp. 36 - 53.*
14. Nguyễn Việt and Ngô Đình Dũng, 2018. *Battle of Bach Dang 1288 - Archaeological evidence of the battlefield. International scientific conference “Bach Dang and Trần Dynasty in the 13th Century global context”.*
15. Nguyễn Việt, Nguyễn Mạnh Hùng, Vũ Minh Giang, 1982. *Quân thủy trong truyền thống chống ngoại xâm (Navy in the anti-foreign invasion tradition). People’s Army Publishing House.*
16. Phan Dai Doan, 1969. *Chiến thắng Bạch Đằng 1288 (Bach Dang Victory 1288). Social Science Publishing House.*
17. Sasaki R. J., 2008. *The Origin of the Lost Fleet of The Mongol Empire. MA thesis, Texas A and M University, College Station.*
18. Sasaki R., Kimura J., D. Ingliss Morriss V., 2012. *The Archaeology of Battle: Magnetic survey of Bach Dang in Vietnam. The INA Quarterly. Institute of Nautical Archaeology. College Station. 39.1 and 2, pp. 24 - 27.*
19. Tong, D.T. and Vu, K., 2011. *Stratigraphic units of Vietnam, 2nd ed., 556 p. Vietnam National University Publisher, Hanoi.*
20. Trần Đức Thanh, 2013. *Basic characteristics of natural conditions of Bach Dang battlefield in 1288). Proceedings of the scientific conference to celebrate the 725th anniversary of Bach Dang Victory, pp.14 - 31.*
21. Trần Tân Văn, Đỗ Thị Yến Ngọc, Nguyễn Xuân Nam et al., 2021. *Report of the Quang Ninh Provincial Science and Technology project “Study on the characteristics, values of geology-geomorphology and biodiversity of Yen Tu Complex of Monuments and Landscapes” (2021 - 2023). Archives of Vietnam Institute of Geosciences and Mineral Resources.*