INFLUENCE OF PALEOGEOGRAPHICAL CONDITIONS ON CHEMICAL COMPONENTS OF GROUND WATER IN THE SOUTHERN PLAIN, VIETNAM

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Abstract

During the history of plain evolution, geographical landscape had been continuously changed, periods of marine transgression and regression superseded alternatively, since then sediment facies were formed appropriately with its geographical landscape. The change of sediment facies – paleography influenced primarily on the formation of aquifer and chemical components of ground water.

The southern plain of Vietnam experienced a complicated and long historical evolution. In Quaternary period, the plain was formed mainly by the deltaic sediments from the river system together with marine sediments. Different geological events caused different magnitudes of sea transgression and regression, displaced the shoreline, governed the flow system and produced corresponding changes such as quantitative distribution, characteristic, and forming condition of deltaic portions as well as other portions in the southern plain of Vietnam. The history of plain evolution plays a very important role in forming aquifers and its chemical components as well.

Deposition period in Late Pliocene (N_2^2)

During this early period, the continental regime dominated to form a stratum consisting of sands, pebbles and gravels and covered the eroded surfaces. The subsequent period, excluding Chau Doc-Rach Gia formation originated from continent, the remaining area was fulfilled by Upper Pliocene sediment of Nam Can formation and Ba Mieu groups (northeast) which lied in unconformity mode over the older geologic formations. The sea transgression from Cuu Long basin was taken place in two directions (figure 1) to form the tortuous shoreline in accordance. The sea occupied 30 percent of the current plain, produced relatively fine sediment including majority of coastal-shallow marine facies of silty clay and silty sand. The coastal plain was influenced by both marine and fluvial processes to produce mixed fluvial, marine, lacustrine, and swampy sediments containing alluvial sand facies, riverbed sand and pebble facies, lake-swamp silty clay and silty sand facies, botanical remains and thin charcoal layers. The surrounding area of the northern plain was in higher altitude and far from the shoreline; it was, therefore, not influenced directly by the sea water but influenced by the tidal regime of the stream and river system. A large amount of sediment was deposited on the plain obtaining mainly from three big rivers of the old Mekong river system. At the current position of Hau River (Back River), Vinh Hung and Chau Thanh area (Tay Ninh province) exposing aggregates of gravel, pebble and riverbed sand facies with large quantity proves the presence of big rivers with strong flows. Near Late Pliocene, the sea started to retrograde to Cuu Long Basin. At that time, the ground water was mainly salty water and brackish water due to the seawater intrusion. Until Late Pliocene-Early Quaternary, the sea completely retrograded away from the plain. The entire plain moved to a new period of uplifting process, deposition interruption and erosion.

Deposition interruption period in beginning of Early Pleistocene (Q_1^1)

This was the stratigraphy interruption period in the southern plain of Vietnam. The entire plain was emerged due to the sea regression to southern Con Son basin. Hence, the entire plain was connected to the uplifting zone of southern Con Son to create an enormous spreading continent. On the plain

surface, a stream and river network was extended to southern Con Son basin, which was in active, to produce a large amount of terrigeneous sediment. During this time, a continental sediment stratum and an aquifer (Q_I) were formed. This aquifer together with the beneath aquifers (N_2, N_1^3) contained fresh and fresh-washing water.

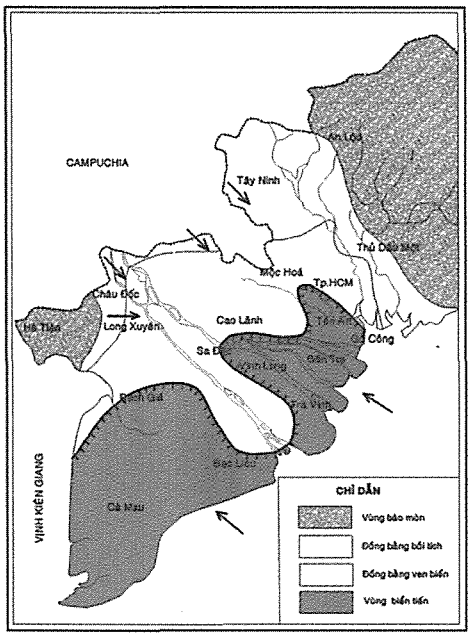

Figure 1. Facies-Paleogeographic map of Southern Plain in Late Pliocene (N_2^2)

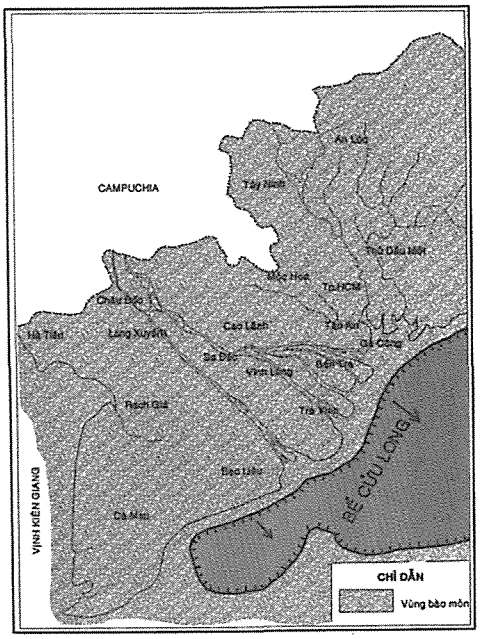

Figure 2. Facies – Paleogeographic map of Southern Plain in early Pleistocene (Q_I^1)

Continental deposition period in end of Early Pleistocene (Q_I^{2-3})

After a long period of deposition interruption, the sea commenced to transgress toward the plain (figure 3). Mixed fluvial-marine-swampy sediment products were formed by the influence of both sea and river processes. On the plain, the altitude was low and relatively flat. There was a prominent event relating to the sediment supply source. It was the appearance of new and large river at the current position of Tien River (Front River) and the reduction of Vinh Hung River (close to Vam Co Dong River) originated from Neogene period. From the integrated and related data, the authors assumed that during and after the continental regime of Late Pliocene to Lower-Early Pleistocene geological events produced huge obstacles to change the flow direction of former Mekong River from crossing Vinh Hung area before to Hong Ngu area at that time and formed the current Tien River at present.

During this period, as a result there were three large rivers transporting the sediment to the southern plain including two former Hau and Chau Thanh Rivers and a new one, Tien river. Those rivers supplied the fine sediments and created the roof of aquifer Q_I^1. Until end period of Middle-Late Pleistocene, the sea had regressed slightly and caused a minor interruption therefore it disappeared in the cross-section profile of northeast region. As a result of this, it produced the salinization in several regions in Q_I^1.

Mixed fluvial-marine deposition period in Middle-Late Pleistocene (Q_{II-III})

The Q_{II-III} sediment spread widely the entire plain including four formations: Rach Gia, Long Toan, Thuy Dong, and Thu Duc. Based on the sediment facies characteristics in the cross profile, it allows

to state the sea transgression during this period larger than the previous period (figure 4) with several private features:

- During the first half period the sea transgression was not as intensive as the second half period.
- A large portion of Ca Mau peninsula was submerged and the sea transgression occupied more widely than in Go Cong promontory and caused the shoreline moving forward far in the land and surmounting Rach Gia, Long Xuyen areas but not farther the left side of Hau River.
- Due to the greater development of sea transgression, greater than the previous period, it induced the redistribution both position and area of two remaining landscape regions with the tendency of increasing the coastal plain area and decreasing alluvial plain area toward the relatively high altitude terrain in the northeast and a small region in northwest.
- The main sediment supply source for the plain during this period was also carried by three large rivers of the Mekong network: Hau River, Tien River, and Chau Thanh River. This period formed the Q_{II-III} aquifer containing mainly salty and brackish water.

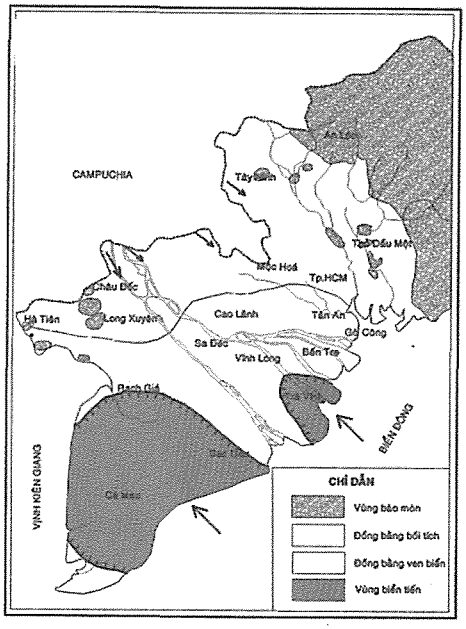

Figure 3. Facies-Paleogeographic map of Southern Plain in midle-uper, early Pleistocene (Q_I^{2-3})

Figure 4. Facies – Paleogeographic map of Southern Plain in lower Midle-Late Pleistocene (Q_{II-III}^{1})

Marine deposition period in Late Pleistocene (Q_{III}^{2})

Right from the commencement, sea transgression occurred rapidly and intensively and obtained the maximum magnitude near the end of this period; it was also the maximum sea transgression toward the plain in Pleistocene. The transgression area occupied more 50 percent of the plain. The sea overflew a portion of the high elevation region between Hau and Tien River, of which the land was never submerged before. Hence, the former two separate straits were connected at that time. The shoreline encroached far in Long Xuyen area at one side and reached deeply in Cao Lanh area at the other side. As a result of this, the marine sediment appeared with a majority of amount in the profile of three formations of Long My, Moc Hoa and Cu Chi. Similarly, the transported sediment in the plain during this period was dependent on three large rivers: Hau River, Tien River and Chau Thanh River. This period also formed the roof of the aquifer Q_{II-III}.

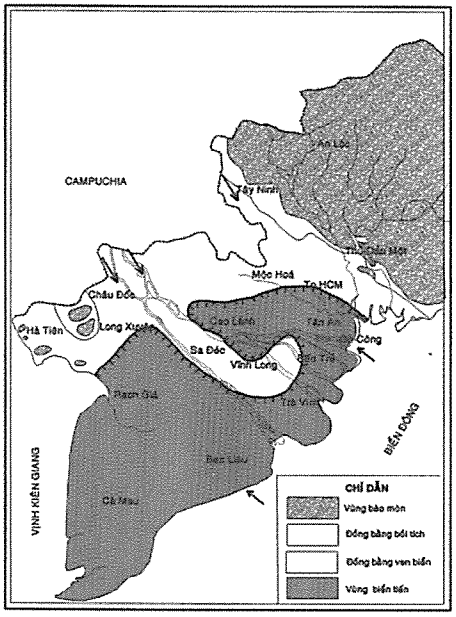

Figure 5. Facies – Paleogeographic map of Southern Plain in midle, Late Pleistocene (Q_{III}^{2})

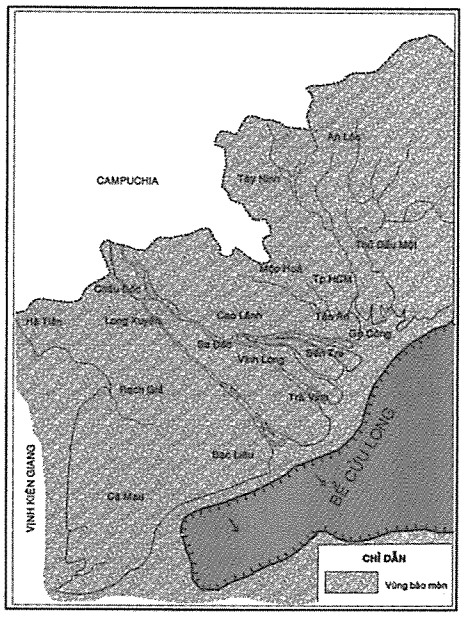

Figure 6. Facies – Paleogeographic map of Southern Plain in upper, Late Pleistocene (Q_{III}^{3})

Deposition interruption period in Late Pleistocene – Early Holocene (Q_{III}^{3}-Q_{IV})

The study result determined that the stratigraphy gap in the plain was occurred during end of Late Pleistocene extending to Early Holocene. The sea regressed completely from the land and retrograded back to Cuu Long basin located in the South China Sea at present. The southern plain was emerged above the sea level, connected to uplifting region of Con Son and surrounding areas to produce a huge continent (figure 6). With that condition, terrestrial sediments were formed on the surface of the plain such as laterite, grit, pebble as well as other alluvial deposits which have been discovered at some locations. During this period, the ground water mobilized with high velocity and rainwater gradually replaced existing water in the previous aquifers. Therefore, majority of the existing ground water was freshly washed excepted the ground water in deeper aquifers.

Marine deposition period in Early-Middle Holocene (Q_{IV}^{1-2})

Before Quaternary never appeared rapid sea transgression as this period. It produced a remarkable amount of marine sediment, much more dominant than other Early-Middle Holocene formations (Q_{IV}^{1-2}) spreading over the southern plain. On the contrary, the fluvial and swampy sediments occupied only a small ratio (figure 7).

Due to the strong transgression and overflow to Cambodia territory, there appeared two landscape regions distributed largely on the other side of Vietnam – Cambodia border.

Salty water broke into the aquifers through "hydro-geological windows", supply source and restored in the aquifers until present. Also due to the sea transgression, the Q_{II-III} aquifer was most affected; the water was mixed; the chemical components were not stable. As a result of the erosion activities caused by the rivers within the region between Hau River and southeast area, a number of hydro-geological windows were formed and encouraged the sea water to intrude directly into the Q_{II-III} aquifers. In the west of southern plain, because there was no big river, the clay layer was eroded a little and created small hydro-geological windows; the influence of the sea was only concentrated in those limited areas.

At the same time, the lower aquifers were influenced less and less in according to the depth; the chemical components were more stable, water was fresher, and the salty water amount became less as well.

At the end of this period, sea regressed slightly and produced more and more sediments of coarser grain size, mixed marine-fluvial origin, appeared on the upper part of the cross section profile of Early-Middle Holocene (Q_{IV}^{1-2}).

In conclusion, during the history of plain evolution, geographical landscapes were continuously always changed; sea transgression and regression periods superseded alternately; since then sediment facies were formed appropriately with its geographical landscape. The change of sediment facies – paleography influenced primarily on the formation of aquifer and chemical components of ground water.

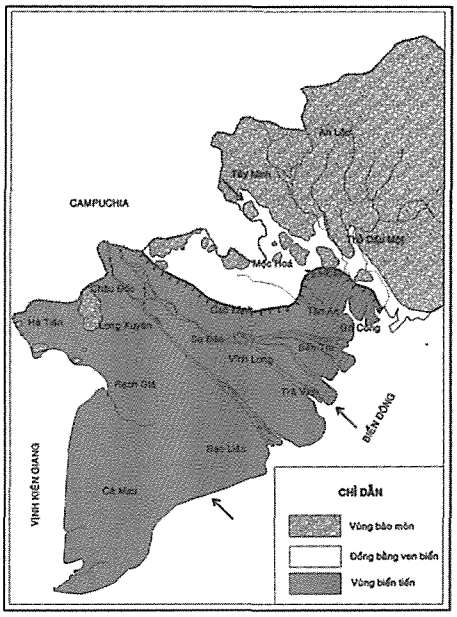

Figure 7. Facies-Paleogeographic map of Southern Plain in early-midle Holoxen (Q_{IV}^{1-2})

Reference

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