DOLOMITIZATION RELATED TO FRACTURE POROSITY EVOLUTION: A CASE STUDY IN PERMIAN RATBURI CARBONATE OUTCROP, YAT PHO SILA THONG DOLOMITE QUARRY – KRABI, SOUTHERN THAILAND

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Abstract

Understanding the nature, style and geometry of dolomitized carbonate reservoirs is of interest in oil and gas exploration and development since the dolomitization process may enhance intra-and inter-particle porosity (sense of Lucia, 2007), so resulting in enriched reservoir properties. Production from Permian Ratburi carbonates is unusual across onshore and offshore Thailand, but does occur in the Nang Nuan oilfield in offshore Southern Thailand and the Sin Phu Horm and Nam Pong gas fields in NE Thailand. Dolomitization in both regions was part of the reservoir diagenetic evolution.

In order to better understand the influence dolomitization has exerted on rock properties in fractured and dolomitized Ratburi Limestone a quarry was studied in detail near Krabi in Southern Peninsular Thailand. Detail fieldwork revealed two dolomite textures, both of which were clearly formed in the burial environment, as responses to an ongoing burial evolution. Diagenetic alteration in the original platform carbonates began with physical compaction, followed by fracturing and faulting that was oriented in N-S direction, clearly revealed that lithology contacts, dolomite distribution and porosity are strongly controlled by structures.

Thus, it seems this type of burial dolomitization in these intensely deformed carbonate terrane has not enhanced poroperm quality. It suggests that either: 1) Dolomitization is not a significant factor in porosity development in the nearby Nang Nuan field; this dolomite in the Nang Nuan carbonate matrix is just a fortuitous association unrelated to porosity enhancement. Or, 2) That there is a different set of fluid processes associated with the dolomite emplacement in Nang Nuan oilfield, which enhanced, not destroyed fracture and matrix porosity. The type of pervasive porosity-occluding dolomitization that occurs in the quarry is called overdolomitization to emphasize that it has destroyed the rock's reservoir capacity in a rock that is 100% dolomite and 0% porosity. It gives a strong contrast to the open intercrystalline porosity that typifies localized dolomite occurrences in faults, fractures and joints in Miocene carbonates elsewhere in SE Asia.

Keywords: Carbonate, Permian, Dolomitization, Fractures

Introduction

Permian carbonate in Southern Thailand, introduced as Ratburi Limestone by Brown et al., 1951, is a known target in oil and gas exploration in southern Thailand basins. It typically has low matrix porosity, from 2% to 5% within limestone matrices (Racey, 2011), but, due to influence of later dolomitization, fracturing and hydrothermal leaching, these same carbonates can locally become very productive reservoirs with up to 15 % porosity and good permeability.

Such changes in the carbonate's poroperm character lead to important questions from an exploration perspective, namely, how extensive is this type of elevated porosity, what diagenetic processes drive its creation, and can its distribution be predicted in the subsurface, so making it an exploration target?.

Location

The investigated outcrop is situated on Changwat Krabi, Amphoea Mueang Krabi (figure 1). It extends 800 meters from West to East and 400 meters from South to North, with beds showing a near-constant N60E to N75E strike and 45°-70° SSE dip direction. Within a geographic perspective, the whole of the study area lies above the plains of the Southern Thailand peninsula region and belongs to the Sibumasu terrane.

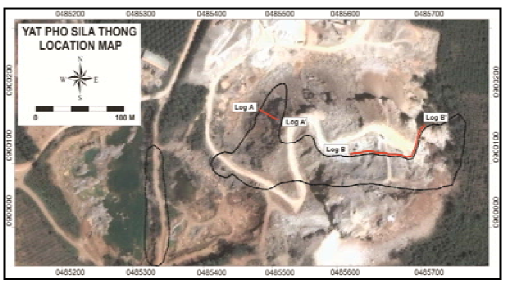

Figure 1. Study area location

Methods

The study integrates fieldwork datasets, Laboratory- processed datasets and literature studies. Fieldwork datasets consist of; measured sections, rock samples, spectral gamma measurements, structural data measurements and field photographs. For the laboratory studies17 rock petrographic samples were made with stained offcuts, and 10 XRD samples run. Samples were sent to Pontifex Laboatories and Monash University laboratories in Australia. The thin sections and laboratory determinations were fully observed in Bangkok during June to July 2012. Field criteria for selected samples to be sent for laboratory analysis were the distinctive textures such as, diagenetic and structural features, and the degree of alteration due to weathering process.

Petrographic observations used a transmitted light optical microscope and included; grain-matrix-cement determination, micro-features indicating deformation or structure, visual porosity and type, and standard micro facies classification were documented. Dolomite classification follows Greg and Sibley, 1987, while the general classification of carbonate rock textures follows Dunham, 1962.

Results

- Rock Units

Observations in the quarry reveal three distinctive rock units;

1. Partially Dolomitized Limestone Unit

Characterized by ESE-WNW bedding, between heavily brecciated blackish calcitic dolomite beds, it consists of fine-coarse crystal-size calcitic matrix and gravel-sized dolomite fragments, with buff brown brecciated dolomite beds, which are made of medium to coarsely crystalline dolomite. Bedding thickness varies from 30 cm to more than 2 meters.

2. Crystalline Dolomite Unit

This unit covers over 60% of the study area; it extends from the gradational contact with Partially Dolomitized Limestone Unit at west part of the quarry to the eastern boundary of the quarry. This unit characterized by ESE-WNW bedding in heavily brecciated blackish to brownish grey crystalline dolomite beds, which consist of medium to coarsely crystalline dolomite matrix, with gravel-cobble size fragments. Bedding thickness varies from 50 cm to over than 4 meters. This unit is cut by swarms of calcite-filled fractures, typically oriented NW-SE and NE-SW. There are only minor appearances of macro porosity associated with this unit, and all fractures in adjacent areas associated with this unit appear to be plugged by cements

4.2.1.3 Speleothem-overprinted Unit

This unit is characterized by narrow bands of heavily leached textures, composed of greenish grey to reddish brown crystalline dolomite, which typically are bounded on one side of its contact by a NE-SW or NW-SE trending fault. As one proceeds further away from the fault, this unit gradually changes back into beds of the crystalline dolomite unit. In term of porosity, this unit is the most porous unit in the study area, the appearance of visible vugs in the quarry outcrop are exclusively localized within the speleothem-overprinted unit and follows the E-W trends of fractures in the quarry.

- Faults

Based on the recorded slicken-sided fault surfaces, which are recorded in lower hemisphere equal area plots, the faulting style within the study area falls into three groups;

1. NE-SW Right Normal Slip fault

This style of faulting appears within the eastern part of quarry, it oriented in N60E-N200E with 20°-65° plunging angle and N170E plunging direction, field observation of the separation gave 30 cm to 2 meter displacements. This feature cuts through the crystalline dolomite in eastern area of the quarry and bounds the appearance of speleothem-overprinted unit within that part of the quarry.

2. NW-SE Right Normal Slip fault

This fault is oriented N170E-N200E with a 20°-75° plunge angle and a N280E plunge direction. It is likely a conjugated pair to the NE-SW Right Normal Slip Faults with the same average 40 cm to 2 meter normal sense of displacement. This feature also bounds the appearance of the speleothem-overprinted unit within the main quarry, and cuts through the crystalline dolomite unit.

3. E-W Normal Slip Fault

This style of faulting is encountered near the western edge of quarry, hard evidence for this fault is mostly at the ST1MS1, ST2MS1 locations with a similar trend of faulting at ST8MS1. The fault is oriented N40E-N70E, with a 65°-70° plunge angle and a N300E plunge direction. This fault has a 30 cm-40 cm displacement, which cuts through the entire previously discussed faulting styles and all the rock units in the western part of quarry.

- Fractures

According to population plots for measured fractures in the quarry area, fractures sets can be grouped into;

1. Group 1; NW-SE fractures
2. Group 2; NE-SW fractures
3. Group 3; WNW-ESE fractures

Group 1 and 2 have vertical dips varying from 55° to 80,° while Group 3 has more sub horizontal dips that vary from 25° to 35°. NW-SE fractures are cut by NE-SW trends and seem to be already embedded within the crystalline dolomite rock unit, before it was overprinted by the WNW-ESE trending fractures. NE-SW and NW-SE fractures are both made up of two groups of fractures, which are; tensional gash fracture and shear fractures. Both are filled by calcite veins or float breccias.

The WNW-ESE fractures are partially open, with 1mm to 10 cm apertures, aligned along the main fault zone and are suspected to have been created by meteoric leaching during Quaternary exposure. This is because partially-open vugs in this fracture set follow the fracture orientations and are filled by indicators of karstic collapse processes, which are terra rossa soil fills and the occurrence of speleothems and speleothem fragments in the fractures. Fracture spacing varies from 2 millimeter up to 1 meter, with decreasing density as we get further away from the fault zone.

- Bedding Style Changes

Rocks in the study area have a consistent bedding attitude, with a steep N60°E-N75°E strike and 45°-70° SSE dip direction.

High-angle bedding attitudes in study area are critical in defining the structural aspects of this study, due in large part to its association with observed fracture kinematics and whether it is a feature that existed prior to bed rotation, or it is not controlled by the bedding rotation at all (fractures are pre existing rotation of the bedding plane). Results of bedding rotation analysis reveal that the NW-SE and NE- SW orientations are post bedding rotation events while the E-W orientations belong to a pre-rotation event, which likely was re-activated. The completed map, showing rock unit distributions and faults in study area, is presented in figure 2.

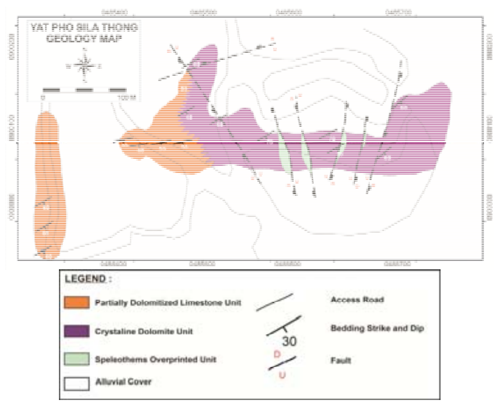

Figure 2. Simplified geology map of studied area

- Spectral Gamma Ray

Two sets of spectral gamma readings across the three different rock units present in the quarry, within the two traverse are explained as follows:

1. Logging Traverse A-A': partially dolomitized unit in this traverse is indicated by readings ranging from 14.9-27.2 API, with variations in U, Th and K readings. On the other hand, crystalline dolomite unit in this traverse is indicated by readings that range from 16.6-25 API.

2. Logging Traverse B-B': crystalline dolomite unit in this traverse is indicated by reading that range from 28-56 API, again with variations in U, Th and K readings, the rocks within transitional passage from fresh crystalline dolomite to speleothems shows readings ranging from 40-56 API, while the speleothem-overprinted unit has readings ranging from 34-57 API. Recorded at least 2 location points were high kicks within this logging traverse, as indicated in the B-B' log. These high readings are not picking the contact between speleothem-overprinted unit and the crystalline dolomite unit; but, based on XRD data, this kick is actually picking radiogenic readings from kaolin-rich mud, which encased inside the speleothem-overprinted unit and smeared along the fault trace. It was likely emplaced at the contact by weathering processes, perhaps overprinting in part a pre-existing clay smear.

The measured spectral gamma shows overlap in Gamma readings from the three units mapped across the study area. Even though some internally consistent clustering of readings occurs in each unit, there is no fix separation result given by spectral gamma ray measurement. It clearly does not indicate different lithology types; successions cycles or give any relationship between gamma responses with the fracture density. However in traverse B-B', the spectral gamma indicates a clay association within the fault that is associated with the speleothem-overprinted unit, which could be useful if we found it also in the subsurface and had a core or a set of image logs to help make sense of the elevated reading .

- Petrography

1. Constituents

There is a lack of recognizable original skeletal and nonskeletal limestone grain constituents preserved in the observed samples from the study area. However, appearances of fenestrate mudstone fragments, peloids, and ghosts of replaced bioclasts are observed.

Matrix typically consists of dusky and cloudy microcrystalline dolomite rhombs, with interlocking crystal boundaries. Very minor amounts of solid micritic calcite matrix were encountered.

Cements are mostly varying combinations of replacive microcrystalline dolomite and cemented vein dolomite. Combinations of replacive cement and interlocking matrix give a tight closed crystalline fabric, with no significant pore space within the crystalline dolomite unit. One of samples contained quartz grains, mixed with peloids, and there was a minor appearance of opaque metalliferous minerals associated with some of the vein filling calcite.

2. Dolomite Texture

Dolomite appears as unimodal planar-S and polymodal non planar-A crystals, with strongly sutured intercrystal contacts. Planar dolomites show clearer internal colors and distinct crystal boundaries, while the non-planar dolomite has a brownish interior crystal colors with cloudy centers and less clearly defined crystal boundaries. Both types appear to completely replace the original allochems in the rocks that, as previously mentioned, are only a minor component of non-replaced mimetic constituents. Most of the occurrences of the two main dolomite crystal textures follow structural trends, as described earlier. Dolomite also occurs as fracture void fills, characterized by a unimodal non planar-A microcrystalline appearance. This last type of dolomite also locally replaces (cannibalizes/post dates) pre-existing calcite veins.

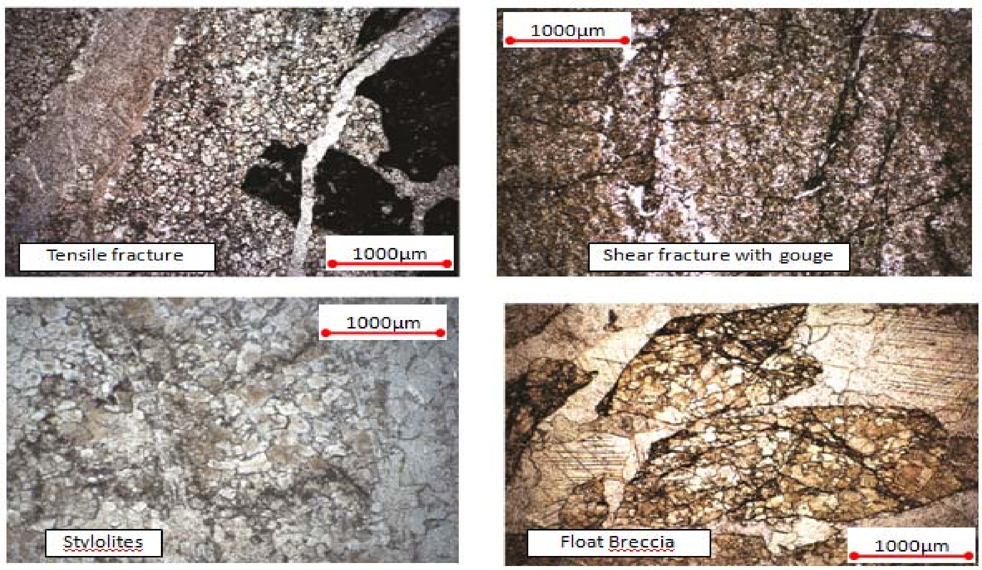

Figure 3. Photomicrographs of representatives features

3. Diagenetic Features

Replacement features appear in most of samples as non-mimetic styles of replacement, there was no evidence of mimetic recrystallization observed in any of the thin sections. Compaction effects are pervasive; the most common are sutured crystal contacts and parallel-to sub-parallel stylolites that post-date the planar dolomite. Completely closed and partially open fractures were observed. The completely closed fractures are plugged by combinations of dolomite fills, fracture-gouge, and pressurized-fluid calcite cements. The latter shows two styles of crystal twinning behavior with one group of calcite vein fills having a thicker lining of twin planes in their crystal interiors compared to the other. Fractures filled by xenotopic dolomite (second style) tend to postdate the hypidiotopic calcite vein fills. Partially open fractures appear as patchy voids with clear dolomite rims. Samples from speleothem-overprinted unit show microcrystalline (micritic) calcite crystal replacement fringes on fragments of dolomite, dissolution voids are lined with isopachous rim cements, and syntaxial growths of bladed needle cements also occur in this unit.

4. Micro Fractures

Petrographic observation reveals the following fracture-related microfeatures:

A. Tensional Fractures: this fracture feature has a sharp fracture wall, which in most cases matches/fits very well when the two sides of the fracture are reconstructed; these fractures are filled by precipitated vein minerals such calcite or dolomite.

B. Gouge/cataclasis filled fractures: these fractures are associated with swarms conjugated of shear fractures. Shear movement during fracturing generated granule/micro fragmentation zones that are confined to the fractures and act to close the fractures when movement stops.

C. Solution-modified fractures: This type of fracture appears; along stylolite contacts; as leached fractures associated with float breccia fill, which appears to be either an injected fill or as cavity fill; and dissolution fractures, which are associated with open vugs and an improved porosity distribution compare to adjacent regions

5. Porosity

Based on samples from each of the three rock units; observed porosity distribution is as follows;

A. Partially dolomitized unit: porosity for samples from this unit indicating patchy partially-open fracture porosity, typically along the anastomose fracture meshes, which cut this unit with E-W trends. Fractures apertures are developed at the mesoporosity scale, with populations making up less than 5% of the rock volume. Mesoscale porosity seems to be localized into isolated zones and not distributed throughout the unit.

B. Speleothem-overprinted unit: porosity from samples from this unit appears as macro dissolution vugs and micro-chalky intracrystalline occurrences that define N-S and E-W fracture systems. Isopachous crystals and bladed needles of calcite can partially or completely occlude the dissolution void. This type of porosity, which can locally constitute 10-20% of the rock volume, is the best porosity style in the quarry, although it is localized to particular fault zones.

C. Crystalline dolomite: No significant porosity was observed from samples of this unit. Instead, replacive matrix with interlocking crystals, and replacive dolomite cements have occluded any former matrix porosity in this rock unit. Pervasive later calcite cement has plugged any residual porosity left over from the planar dolomite event so that the fractures leave behind a very minor ineffective porosity in this unit with a porosity population that is less than 2% of the rock volume.

Discussion

1. Age and Deposition Environment

A lack of age-diagnostic fossils means the highly dolomitized rocks in study area are difficult to place in a proper age bracket, however regional information summarized in figure 1 suggest that the outcrop is Permian. Three observations in the petrographic samples, and the remnant fenestrate texture encountered in the outcrop, guide a tentative interpretation of depositional environment. Appearance of cemented peloids, along with quartz grain contamination and fenestrate textures, implies a lagoonal to peritidal depositional environment with minor siliciclastic input. We know The outcrop is a heavily brecciated and altered set of rocks, where ongoing diagenesis has blurred distinctions between depositional breccias and fault breccias. Even so, the depositional setting interpretation, based on textural remnants in three samples, is consistent with extensive work by Ueno & Charoentitirat, 2011 that interprets the Ratburi limestone on the Sibumasu block as a shelf carbonate platform sediment.

2. Diagenetic History

The history of diagenesis and processes are interpreted in this current report based solely on petrographic observations, when associated stable isotope data become available they can be used to refine this diagenetic interpretation. Even though pre-burial diagenesis within these rocks is fully overprinted by replacive dolomitization processes, floating fragments of muddy carbonate with possible desiccated features are still encased in a dolomite matrix suggesting a pre-existing episode of marine (eogenetic) cementation, followed by pervasive burial overprints. Burial processes involving massive physical compaction, which marked by sutured crystal contacts, indentation and dolomite crystal alignment. Replacive dolomitization processes, with a planar crystal product, is bracketed between post-physical compaction and the ongoing stylolitization process. As noted by Bathurst, 1995 the onset of stylolitization can be at moderate burial depths (700-1000 meter). In the study area this is probably about the same depth realm where the first dolomitization began. These processes are postdated by fracturing and non-ferroan calcite vein cementation; based on the recorded orientation of samples, most of the earlier fractures are oriented in NE-SW and NW-SE directions. Crosscutting field relations between the two fractures imply the fracturing did not happen within the same stage; NW-SE fractures are overprinted by the NE-SW fracture trend. These features are overprinted by replacive, nonplanar/ xenotopic dolomite crystals following an N-S and NE-SW trend.

Partially-neomorphic micritization overprinted the previous set of processes, followed by E-W fracturing and another episode of nonferroan isopachous- fibrous calcite cementation and ended with partial calcite dissolution. The summary of the inferred diagenetic history is presented in figure 4.

3. Dolomitization Mechanism

Appearances of boxwork and brecciated textures within the crystalline dolomite unit and also sutured crystal contacts imply that dolomitization process in the study area is a post-depositional process and highly controlled by structurally-induced conduits (Sibley and Gregg, 1987). Dolomitization is pervasive within the main quarry area, but also in a narrow passage of dolomitization lateral coverage, in a more regional dolomitization largely confined to the quarry area and its immediate surrounds. On this background, writer proposes another dolomitization mechanism which probably differ from previous documented study result might be appear in study area.

There already existing documented marine diagenesis dolomite (Baird & Bossence, 1993). These types of dolomite have characteristic isotope signatures that can be tested against the isotope signatures of samples collected in this study later after we got the full result, which in thin section appear to be show much later burial textures dominated by sutured crystal boundaries. In addition, previous work has documented vein-associated euhedral coarse-crystalline cement fill dolomite, which is suspected to be the product of granite-emplacement fluids (Owas Chinoroje, 1993). These previous documented dolomitization products are expected to be regional overprints in the Ratburi limestone.

Appearance of two distinctive dolomite textures in the study area could be one of the main keys to unfolding an understanding of the dolomitization process in central and southern Thailand. According to Machel, 2004 and supported in a very intelligent discussion by Kaczmarek & Sibley, 2007, massive dolomitization by freshwater-marine water mixing is a myth. They show pervasive dolomitization could only happen via thermal convection in an open hydrologic system, which involves saturated or sea brines. Crystal shape and manner of the dolomite precipitation in such a system varies according to the temperature of crystallization with two end member settings or styles: 1) planar etch and coarser crystal sizes will be developed in a lower temperature diagenetic realm at normal fluid saturations in the dolomitization fluid, while 2) mounded - erroneous etch (amorphous) and smaller crystal sizes tend to associated with a faster precipitation timing, at higher temperatures of crystallization, with higher fluid saturations (supersaturation).

The best scenario for the first set of dolomitization processes (style 1) is where the limestone platform is flooded by dolomite-saturated fluids after physical compaction has taken place in the moderate burial realm, possibly up to 1000 m deep, as indicated by stylolite appearances (Bathurst, 1995). The appearance of zebra dolomite textures suggest that the dolomitizing fluids pass through the bedding planes and along tensional fractures. The second dolomite style, which also occurs in the study area, is associated with boxwork and brecciated textures, and also with the appearance of nonplanar dolomite with erroneous dissolved contacts with the planar dolomite. The style occurs in the quarry along NE-SW trend, supporting the idea that faulting and fracturing control the initial distribution of this type of dolomitization process. Thus, looking at dolomite distribution in the quarry supports the ideas of Machel, 2004 that much of the crystalline dolomite unit in the quarry is a fault "squeegee" type of dolomitization. Such dolomites are the result of massive dolomitization via hydrothermal solutions that ascend rapidly through fault systems and resulting in pervasive dolomite in the vicinity of the sheared or faulted zone. Kaeng Krachan Fm. sediments, which are glacio-marine, possibly contained modified seawater as a formation fluid, are one possible candidate for the dolomitization fluid supplier. Fluid circulation and migration could possibly have been driven by overpressure, but could also be tied to flows from deep-seated fault shears or to granite emplacement fluids (Charusiri, 2012 *pers comm*).

Faulting and fracturing associated with the dolomitization conduits could include initial fault onset and reactivation processes, which have taken place in the quarry from the Indosinian to the Neogene, due to NE-SW and NW-SE trend could related to Neogene Khlong marui deformations while E-W could related to reactivated fractures from Indosinian I deformation (as revealed by unfolding of bedding rotation). Unfortunately it is not feasible to bracket the fluid timing of the fault related dolomites without isotope data support.

However this tentative interpretation still needs to be supported by additional research data such as; mapping of surrounding similar dolomite distributions, stable isotopes, fluid inclusion study, temperature measurement and strontium isotope analysis in order to confirm any proposed relationship between; dolomite distribution with main fault zone, dolomite fluid compositions, crystallization temperatures of dolomite and also absolute timing of dolomitization events.

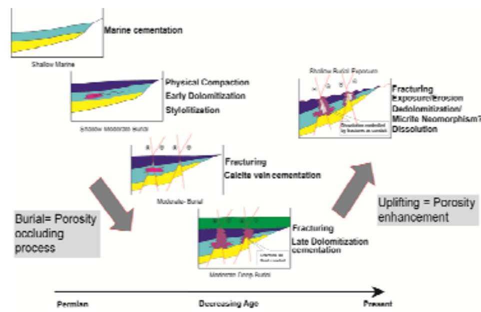

Figure 4. Paragenetic story of the studied Permian Ratburi

4. Impact on Reservoir Characteristic

The effect of the dolomitization process in the Permian Ratburi rocks in the study area is that it has completely occluded matrix porosity. Multiple fracturing stages and partial subsurface dissolution has been followed each time by pervasive vein cements and so have not enriched porosity of the rocks, even though fracturing has happened a number of times in the subsurface. Even though evidence of open fractures exist in a few samples, the co-appearance of fault or fracture gouge and calcite vein cements, clearly indicate how fragile is the expectation of these porosity types to be effective and highly connected forms of porosity to be maintained in the subsurface.

5. Comparison with Surrounding Dolomite - associated reservoir

There are only a few publications dealing with hydrothermally-modified fluids driving dolomitization and reservoir character in the Southeast Asian context, although the number works concluding the importance of later subsurface fluids as a porosity enhancer is growing, especially in Miocene carbonate buildups deposited in back-arc basins (Carnell and Wilson, 2007). Even in Permian reservoirs, the notion of hydrothermal enhancement is growing; Nang Nuan oilfield (Heward et al., 2000) was initially believed to be a product of subaerial exposure and meteoric diagenesis. Later it was found to possess a 20°C higher fluid temperature, compared to the surrounding formation water and to show massive drilling fluid loss in a number of wells after encountering a heavily dissolved limestone host reservoir. These fluid loss intervals were tied to intensive bathyphreatic karst zones with burial vugs developed almost parallel to the bedding plane. This evidence leads to idea where dolomitization is not a responsible subject to reservoir quality enhancement in Nang-Nuan fields.

6. Implication to the Petroleum Exploration and Development within the Nearby Area

What is of reservoir quality importance, based on the study area, are its open fractures, partial fracture infills and widespread meteoric dissolution processes, driven by exposure and uplift. This set of karstic processes is tied to the pre-existing structural grain and is enhancing porosity and permeability in the outcrop.

This type of “buried-hill” play (based on the study area) would need to be covered by a seal facies and also to be charged with the right hydrocarbon timing, soon after porosity enrichment. This needs to happen in order to retain or partially retain the enhanced porosity before it undergoes another stage of pervasive cementation

This kind of exploration play will be associated with intercepted exposure surfaces of Ratburi carbonate within paleohighs in a basin, which were overlain by marine or lacustrine shales, subsequent to exposure and after karstification. In addition, it must be associated with an appropriate combination of source, migration and seal integrity in the overburden. Within a field development perspective, the effective reservoir porosity and permeability would be associated with fracturing and dissolution, with preferred flow directions, which were controlled by the latest faulting.

1. Conclusions

There two groups of dolomite with two different sets of textural characteristics (and likely also distinct stable isotope character); the first dolomite group are the unimodal planar-S dolomites with clearer internal crystal colors and distinct crystal boundaries, the second dolomite group are the polymodal non planar-A dolomites with brownish internal color, cloudy crystal centers and less clear boundaries which often show sutured contacts.

Both of this dolomite groups appears only within a narrow outcrop band that extends less than 6 km from the study area. Its occurrence is suspected to be associated with fluids escaping along fault conduits from the strongly deformed Khlong Marui shear zone. The impact of shear deformation is clearly reflected in structural trends and faulting styles in the study area where there are well-developed conjugate sets of NW-SE, NE-SW and WNW-ESE faults and fractures. Fractures cut across the study area, often resulting in sheared gouges and brecciation. There are only a few preserved open tensile fractures in the quarry area, most are closed and cemented.

The appearances of dolomites, which are an unusual lithology compared to the limestone outcrops of the surrounding area, are highly localized to the quarry region. There the sheared/deformed bands of fault conjugates, with differing dolomite textures, clearly provide another dolomitization mechanism (other than older interpretations of dolomites in Thailand forming in mixing zones). Dolomite texture and distributions in the quarry area suggest a fault-controlled set of dolomitization processes with a localized dolomite product. But this idea still needs to be further tested, due to the lack of supporting stable isotope data.

Dolomitization within the study area is very pervasive, almost the entire original texture was replaced by dolomites and all the initial porosity is occluded. These types of pervasively dolomitized rocks (over-dolomitised) are not an ideal type of reservoir. The only processes that occur within the study area, and are enhancing porosity and permeability, are the result of Neogene-Recent dissolution and karstification, created by meteoric water circulation in the shallow subsurface.

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