CERAMAH TEKNIK TECHNICAL TALK

Dolomitization and Porosity

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21 May 2014
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Prof Dr Rick Major presented a talk entitled "Dolomitization and Porosity" on 21 May 2014 at University of Malaya. Dr. Major is Shell Chair in Petroleum Geoscience at the Department of Geosciences, Faculty of Geosciences and Petroleum Engineering, Universiti Teknologi PETRONAS. The talk chaired by Dr. Ralph Kugler was attended by academics and postgraduates from University of Malaya and geoscientists from the industry.

Abstract: In the late 1950s and early 1960s Shell researchers at the Bellaire Research Center in Houston presented two contradictory hypotheses for how altering limestone to dolomite influences porosity. Peter K. Weyl proposed, and published, a mole-per-mole (conservation-of-mass) model for dolomitization which resulted in increased porosity (Weyl, 1960). F. Jerry Lucia proposed, but did not publish, a volume-for-volume plus cementation model that resulted in decreased porosity. In 1983 Robert B. Halley and James W. Schmoker, both with the U.S. Geological Survey, independently arrived at the same conclusion as Lucia (Halley and Schmoker, 1983). These two "endpoint" models, and a third "in between" model, are still debated inside and outside Shell today.

Weyl based his model on two observations. First, the enormous and prolific oil reservoirs in the Permian Basin of west Texas and southeastern New Mexico are dolomite; there are no major limestone reservoirs. Second, most modern groundwaters contain very little carbonate. He proposed that the source of carbonate must be the original limestone. Inasmuch as dolomite is a more dense mineral, conservation of mass would result in a smaller mineral volume and increased porosity.

Lucia based his model on observations of the Plio-Pleistocene Seroe Domi Formation on Bonaire, Netherlands Antilles. Dominantly aragonite fore-reef grainstones, which had been stabilized to low-magnesium calcite during early exposure to meteoric water, were subsequently dolomitized by downward and outward flowing hypersaline brines. Updip dolomites have low porosities, downdip dolomites have higher porosities, and farther downdip limestones have the highest porosities. Importantly, the boundary between updip dolomites and downdip limestones is composed of partly dolomitized rocks which contain both replacement dolomite and dolomite cement. The rocks started to lose porosity as soon as dolomitization began (Major and others, 1992a; Lucia and Major, 1994; Lucia, 2004).

A number of workers have suggested a third hypothesis. This model proposes that during dolomitization replacement occurs first, resulting in increased porosity. This is followed at a later time by dolomite cementation, which decreases porosity (for example, Jones and Xiao, 2005). Lucia has seen no data to support this hypothesis, although it has been used as the basis for published computer simulations and remains the subject of both formal and informal discussion.

Observations on Bonaire led Major and others (1992b) to propose that the geochemical composition of some dolomites may be used to interpret the pathways of dolomitizing fluids. Dolomite unit cell dimensions in the Seroe Domi Formation of Bonaire are more compact proximal to the source of dolomitizing fluids and less compact distal to the source. This is a fast and inexpensive method for interpreting the pathways of dolomitizing fluids and may serve to both constrain the source of these fluids and predict porosity patterns. Dolomite unit cell dimensions in some Permian and Ordovician rocks have apparently preserved dolomitizing fluid pathways formed early in their diagenetic history.

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