

Compositional Grading in the Oil Column – Advances from a Mass Balance and Quantitative Molecular Analysis

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Compositional grading in oil columns has been known for fifty years, but the topic received little attention until the 1980's when sufficient analytical technologies became available to probe the phenomenon. Compositional grading is most commonly associated with thick oil columns and is promoted by a reduction in pressure and temperature, as well as by the introduction of volatiles. Oil properties that increase with depth include the C7+ mole fraction and dewpoint, whereas a decrease with depth is noted for the C1 mole fraction, gas/oil ratio, and bubblepoint. End-member compositional trends include asphaltene precipitation and tar mat formation at the base of the oil column, and concomitant formation of a volatile rich liquid phase at the top. The evolution of the oil column from a mass balance perspective (Figure) is accompanied by distinct molecular fractionations that can be used to diagnose the state of oil column disequilibrium. This diagnosis step is a critical aspect of tool selection in the planning and preparation stage of the reservoir continuity workflow.

A case study of compositional grading is provided by the hydrocarbon resources of the Val D' Agri region within the Southern Apennines Thrust Belt (Italy). The carbonate reservoirs include karsted vuggy intervals, as well as extensively developed fracture systems. This combination of tectonic setting and reservoir character contribute to unstable oil columns (600 to 1000 meters thick) where the oil fractionates the heavier components towards the base (12°API) and volatiles toward the top (54°API). Specific molecular fractionation trends are identified from volatile, intermediate, and heavy molecular weight fractions (hydrocarbons plus organic sulfur compounds). The results have direct application to devising a successful strategy to identify reservoir compartments.

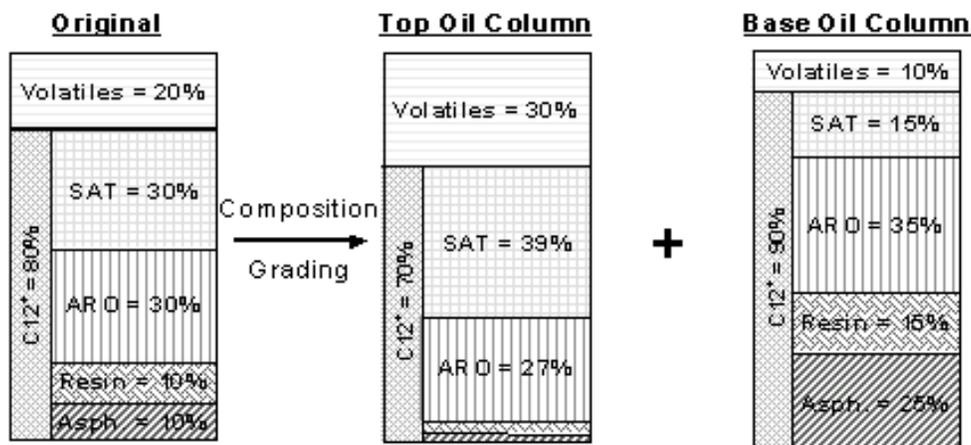


Illustration of the mass balance relationships that occur when an oil is altered by the compositional grading process.