General Model for Delivery of Asphaltenes to Tar Mats

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A tar mat can be understood only in relation to the history of the hydrocarbon system of the entire basin. The following facts and assumptions should underlie any tar mat model. 1) Source: all asphaltene molecules are derived from the source, not created in the reservoir; early-generated oil has low API gravity and abundant asphaltenes; late-generated oil has high API gravity and rare to nonexistent asphaltenes. 2) Migration occurs as threads or blobs of oil tracing only the highest crest of the nose leading to the crest of the reservoir. 3) Fill: early, asphaltene-rich oil fills the attic of the reservoir and is pushed downward by later, asphaltene-poor, high-API oil; assume asphaltene molecules diffuse slowly so oil volume remains stratified during fill; late oil causes gas-deasphaltinization (light molecules migrate from asphaltene-rich to asphaltene-poor oil); although gas deasphaltinization occurs at the point of contact between migrating light oils and already-reservoired heavy oils, tar is produced in very small volumes localized at the very crest of the nose leading to the crest of the reservoir because the heavy oil is constantly pushed downward in the reservoir. 4) Spill: the first oil to reach the contemporaneous spill point will be heavy oil, which will start to spill to the next trap up dip; lateral migration of the heavy oil toward the spill point will be slow in comparison to vertical migration of overlying light oil, so a heavy oil layer will persist around most of the field; light oil migrating into and through the now-stationary heavy oil will form tar, blocking the nose-crest migration pathway and causing the migration pathway to become convoluted and expanding the area of tar formation; light oil rapidly migrating up a high-perm streak may “drag” asphaltene-rich heavy oil along with it, causing tar to finger up the high-perm streak until perm is blocked by tar and the preferred migration pathway moves to another part of the heavy-oil/water contact. Differences in surface chemistry of carbonate vs. siliciclastic minerals probably result in different rates of tar formation vs. asphaltene diffusion so the same basin-wide history may produce more tar in carbonate reservoirs than in siliciclastic reservoirs. To the extent that “all” tar mats are formed by gas deasphaltinizaton, then “all” tar mats must be formed when reservoirs are filled to contemporaneous spill. Assumptions in this model can, in theory, be lab tested.