

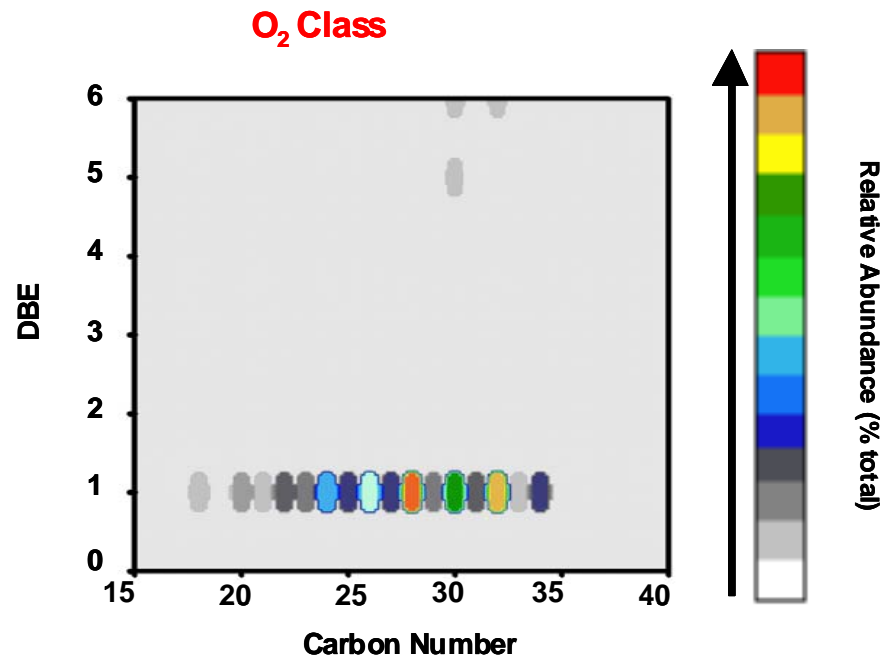
# Chemistry of Petroleum Crude Oil Deposits: Sodium Naphthenates

2009 NHMFL Science Highlight for NSF

DMR-Award 0654118

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Solid deposits and emulsions from crude oil can form by the interaction of naphthenic acids with divalent (calcium; magnesium) or monovalent (sodium, potassium) ions in produced waters. We have determined detailed chemical compositions of calcium and sodium naphthenates from the field based on high resolution Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS). The Figure shows that sodium naphthenate deposits consist mainly of specific straight-chain carboxylic acids: saturated [i.e.,  $(-\text{CH}_2)_n$ ] carbon chains terminated in a  $-\text{CO}_2\text{H}$  group containing a single  $\text{C}=\text{O}$  double bond. Understanding the specific chemical nature of such deposits is the first step toward preventing their formation.



Plot of double bond equivalents (rings plus double bonds to carbon) versus number of carbons in those sodium naphthenate deposit molecules that contain carbons, hydrogens, and two oxygen atoms.

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A major problem in oil production, both at the wellhead and in refining, is deposits (see Figure at left) that clog pipes and processing equipment. With high-resolution mass spectral "fingerprinting", we are able to identify potential deposit compounds *before* they precipitate, allowing oil producers to evaluate the oil quality for a given refinery and/or choose appropriate additives to prevent deposition.

Mapolelo, M. M.; Stanford, L. A.; Rodgers, R. P.; Yen, A. T.; Debord, J. D.; Asomaning, S.; Marshall, A. G., "Chemical Speciation of Calcium and Sodium Naphthenate Deposits by Electrospray Ionization FT-ICR Mass Spectrometry," *Energy & Fuels* **2009**, 23, 349-355.