Introduction  Several new technologies have been developed and applied that provide more detailed insights into petroleum systems, beyond the capability of classical biomarker analyses. We refer to these as high resolution geochemical technologies (HRGTs). We will show applications to petroleum system studies in major petroleum producing regions of Latin America and elsewhere to illustrate these new technologies described as follows:

Diamondoid-biomarker analysis for cracking provides the only reliable parameter for thermal-cracking that can be measured for any produced liquid hydrocarbon sample. Precision concentration measurements of 3- and 4-methyldiamantanes and stigmastane are made using 1-d_{3}-methyldiamantane and 5β-cholane in GCMS. The 3- and 4-methyldiamantanes ppm measurements are transformed into percent-liquids-conversion (% of cracking) using the formula \[1 – (C_0/C_C)\]*100, where \(C_0\) is the concentration of diamantanes in non-cracked samples and \(C_C\) is the diamondoid concentration in measured samples. From these % conversions can be estimated average vitrinite reflectance and approximate depth to the source rock, in some cases. Oils that carry signatures of extensive cracking together with significant stigmastane concentrations are recognized as mixed from post-mature and normally matured sources. Liquids showing high cracking profiles provide a clue to gas migration, since thermal gas usually carries along with it sufficient condensate to provide a genetic diamondoid signature (see also CSIAD, below). Thus, the diamondoid-biomarker cracking analysis has become a valuable tool for showing regional migration routes and deep sources for thermal gas.

Age-related and taxon specific biomarkers have been developed for finding divisions between certain geologic time periods concerning the age of the source of an oil sample. Some key parameters follow: dinoflagellate and haptophyte markers (dinosteranes, 4-desmethylsteranes) break between the Paleozoic and Mesozoic; diatom markers (24-norcholestanes) show breaks between the Tertiary, Cretaceous and Jurassic and \(C_{25}\) highly branched isoprenoids break at the Turonian Stage; angiosperm markers (oleanane, lupane) break between Jurassic, Cretaceous and Tertiary, green algal markers (tricyclic terpanes) break Triassic and Jurassic.

Compound specific isotope analysis of biomarkers (CSIAB) and diamondoids (CSIAD) give a detailed source-specific biomarker- or diamondoid-isotope fingerprint. Oils that show sufficient biomarker concentrations (typically up to about the mid oil window) can be separated into \(n\)-alkane, isoprenoid, sterane and hopane fractions suitable for CSIAB analysis. Oil families that are difficult to distinguish by other means and mixed oils from multiple families can often be distinguished and de-convoluted, respectively, by using this burgeoning technology.

CSIAD compliments CSIAB by providing an isotopic fingerprint that may neither be altered by extreme catagenetic conditions in the source rock nor by alterations in the reservoir, like thermo-chemical sulfate reduction (TSR) and biodegradation. Therefore, post-mature, TSR altered and biodegraded oils may be correlated with non-altered oils of normal maturity by CSIAD. This may be one of the most specific ways to correlate oil with highly mature condensate, as a proxy for associated gas, and thus provide information about gas provenance in a basin.