

# Comparison of Interfacial Tension Reduction in Toluene/Water System by Colombian Crude Oil and its Interfacially Active Components

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## Aromatic and Aliphatic Signal Relation

Figure S1 shows the crude oils and fractions proton NMR spectra of C1, C2 and C3. We use the ratio<sup>50</sup> between the integrated area assigned to aliphatic protons ( $H_{al}$ ) in the 0.5ppm to 4.5 region and the integrated area assigned to aromatic protons ( $H_{ar}$ ) in the 6.5ppm to 9.0ppm region as indicator of similitude between fractions and aromaticity. We found the same tendency in the three samples. Maltenes and asphaltenes are very different, the former are predominantly aliphatic with  $H_{al}/H_{ar}$  ratios between 13-15 and the latter are predominantly aromatic with  $H_{al}/H_{ar}$  ratios between

4.8-5.2. Nevertheless, interfacial material  $H_{al}/H_{ar}$  ratios observed are between 7-10, halfway the  $H_{al}/H_{ar}$  ratios of the other two fractions. This is evidence that the interfacial fraction may be constituted by compounds of both, maltenes and asphaltenes or that the structures of relevant surfactants contains aromatic segments, as the asphaltenes, and aliphatic segments, as the maltenes.

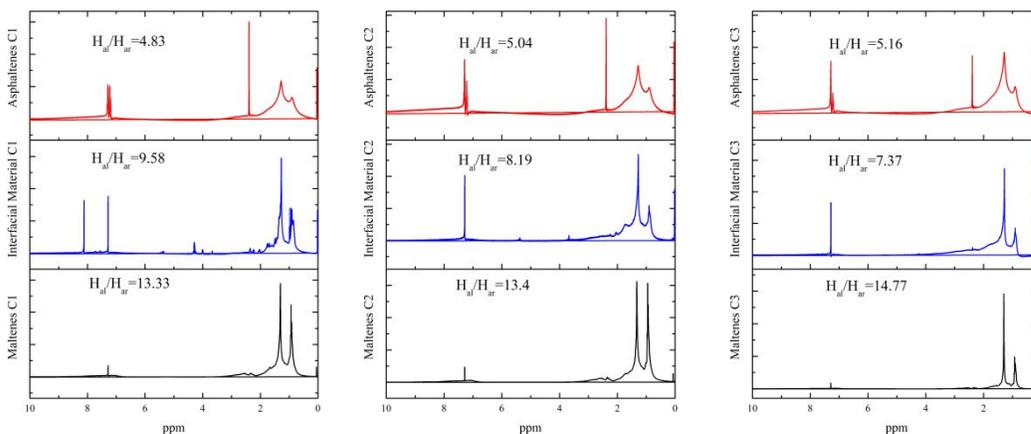


Figure S1. Proton NMR spectra of maltenes (MA), interfacial material (IM) and asphaltenes (AS).

## Mass Distribution

We use laser desorption/ionization mass spectroscopy to compare mass distribution among fractions. Figure S2 shows the mass spectra of crude oils, asphaltenes and interfacial material.

Maximum intensity was observed about 280-300 m/z in all spectra, nevertheless asphaltene and interfacial material spectra exhibit a secondary distribution between 400-500 m/z that was not observed in crude oils spectra. This was attributed to the presence of heavier polyaromatic compounds in those fractions. This similitude suggest that interfacial material extracted includes subfractions of the asphaltenes. Additionally, we calculated number average molecular weight ( $M_n$ ), weight average molecular weight ( $M_w$ ) and polydispersity index (PDI) using equations 4, 5 and 6, respectively. Where  $I_i$  correspond to the intensity and  $M_i$  is the mass of each peak in the spectra. In table S1 we show these results for comparison. PDI of asphaltenes is greater because of the peaks distribution between 700-2500 m/z. This has been attributed to nanoaggregate formation of asphaltenes induced by laser desorption<sup>51</sup> and the presence or formation of fullerenes<sup>52</sup>. Either way, this was not observed in interfacial material or crude oil spectra.

$$M_n = \frac{\sum I_i M_i}{\sum I_i} \quad (4)$$

$$M_w = \frac{\sum I_i M_i^2}{\sum I_i M_i} \quad (5)$$

$$PDI = \frac{M_w}{M_n} \quad (6)$$

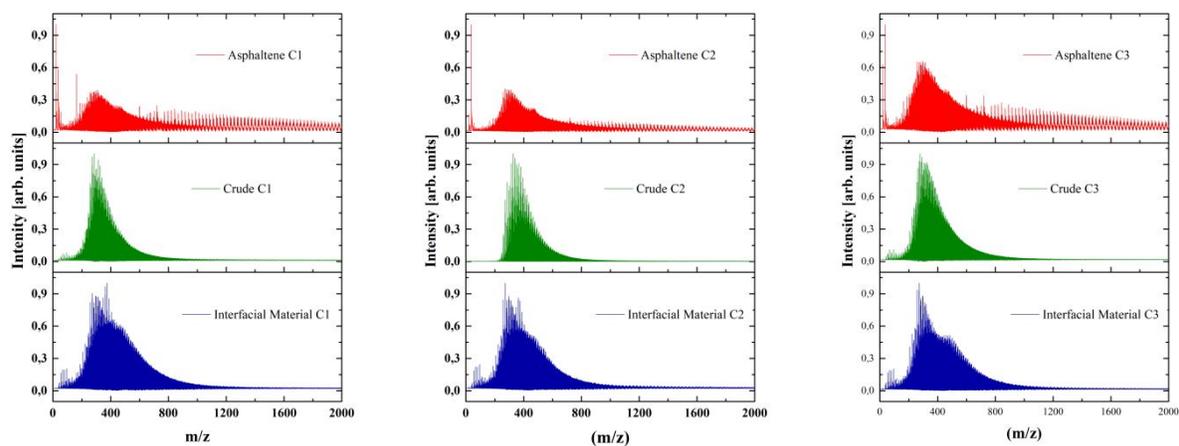


Figure S2. LDI-MS spectra of crude oils and fractions.

Table S1. Average molecular weights and polydispersity indexes of crude oils and fractions.

		<b>Mn</b>	<b>Mw</b>	<b>PDI</b>
<b>C1</b>	Asphaltenes	799	1415	1,77
	Crude oil	416	578	1,39
	Interfacial material	480	624	1,30
<b>C2</b>	Asphaltenes	700	1218	1,74
	Crude oil	521	688	1,32
	Interfacial material	490	704	1,44
<b>C3</b>	Asphaltenes	732	1257	1,72
	Crude oil	440	614	1,40
	Interfacial material	479	660	1,38