COMPARISON OF VERY LOW SULPHUR FUEL OIL WITH SPILLED OIL FOLLOWING GROUNDING OF MV *WAKASHIO* IN MAURITIUS, 2020

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Introduction

On the 25th July 2020, the bulk carrier MV *Wakashio* ran aground on a coral reef offshore of Pointe d'Esny, Southeast Mauritius releasing an estimated 1000 t of fuel oil into the Indian Ocean threatening internationally important wetlands.[1,2] The MV *Wakashio* was reported[3] to be carrying approximately 3,800 t of Very Low Sulphur Fuel Oil (VLSFO, defined as <0.5 % S[4]), 200 t of diesel oil, 100 t of lubricant oil and residual oil. In an attempt to reduce toxic emissions from the burning of heavy fuel oils containing high concentrations of S, ships are increasingly using VLSFO.[4] Following the grounding of the *Wakashio* there has been much confusion about what was spilled and speculation in the media concerning conspiracies and cover-ups.

A sample of oil was collected from close to shore (20°23'49.7"S, 57°41'58.3"E) on 16th August 2020 by a volunteer worker and subsequently shipped to laboratories of the Western Australian Organic and Isotope Geochemistry Centre (WA-OIGC), Perth, Australia and Woods Hole Oceanographic Institution (WHOI), USA. A sample of *Wakashio* fuel oil was obtained from Sintef, Norway. The samples were analysed as whole oils diluted in dichloromethane by two-dimensional gas chromatography with Flame Ionisation Detection (GC×GC-FID) and with high resolution mass spectrometry (GC×GC-HRT) at WHOI. At WA-OIGC, the maltene fraction of the oils were separated by silica gel chromatography into saturate (100% hexane), aromatic (7:3 hexane: dichloromethane), polar (1:1 $MeCl_2$:methanol) and highly polar (100% methanol) fractions following precipitation of asphaltenes by repeated addition of chilled *n*-heptane and centrifugation. Fractions were analysed by gas chromatography mass spectrometry (GC-MS). In addition, the oils were subject to compound specific isotope analysis (CSIA) by gas chromatography isotope-ratio mass spectrometry (GC-irMS) to compare $\delta^{13}C$ and $\delta^{2}H$ of *n*-alkanes and isoprenoids. Elemental analysis was performed by inductively coupled plasma-mass spectrometry (ICP-MS).

Results

A full characterisation of the organic components of the oil collected in Mauritius by GC-MS and GC×GC-HRT revealed it to be unlike any previously seen spilled oil. The aromatic fraction was in particularly low abundance. Sulphur-containing heterocyclics were also in very low abundance. Suites of steranes and diasteranes were identified by GC×GC-HRT but were in low quantities. Triterpanes and hopane biomarkers, including *seco*-hopanes, helped to establish a profile of the oil that can be used for future fingerprinting of spilled oils. Additionally, a suite of C_{15} and C_{16} bicyclic *ses*quiterpanes were also present. Elemental analysis of the spilled oil showed that it contained only ~0.2% S which is well within the limit for VLSFO. Both vanadium and nickel were present in relatively low abundances. Stable isotopic analysis of the spilled oil revealed that $\delta^{13}C$ values for isoprenoids were not significantly different to that of the corresponding *n*-alkanes. For $\delta^{2}H$ however, there were a distinct offset with pristane and phytane showing more negative values.

A preliminary comparison by GC-MS of the spilled oil with the VLSFO used by the MV *Wakashio*, showed the former to have generally reduced abundances of saturated hydrocarbons with *n*-alkanes <*n*-C_{13} lost (Figure 1). Diagnostic ratios of the isoprenoids and *n*-alkanes were very similar (Figure 1). Biomarker profiles were also similar in the two oils. Comparing the suite of C_{15} and C_{16} bicyclic *ses*quiterpanes, some differences consistent with evaporation were observed of the lower molecular weight compounds.

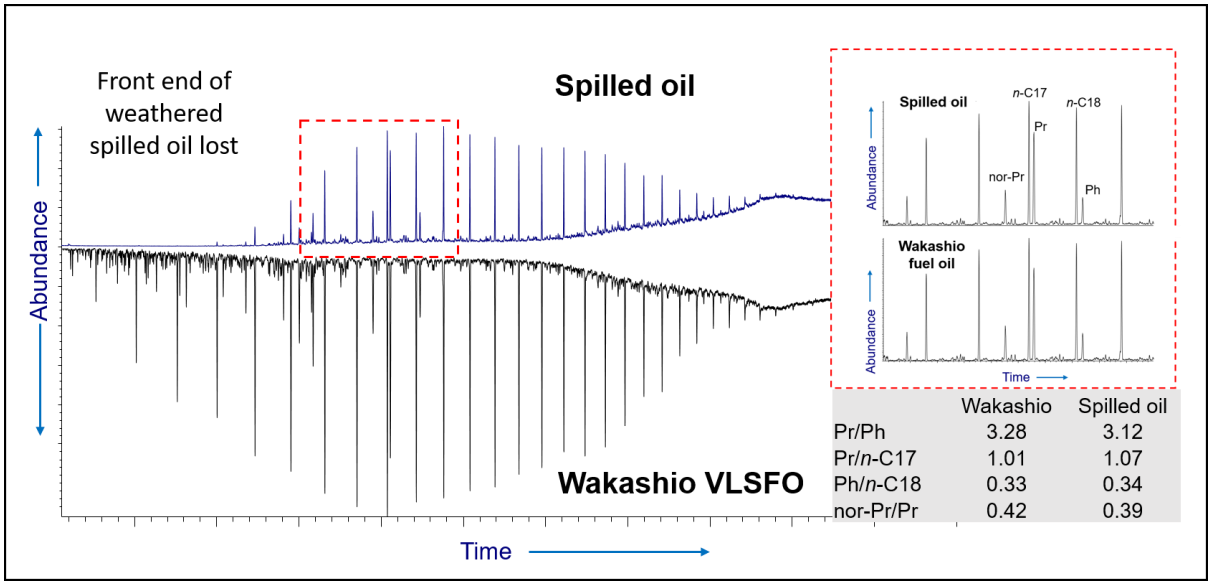

Figure 1 *Comparison of the saturate fractions of oil sampled from nearshore Mauritius three weeks after grounding of the MV Wakashio (top) and Very Low Sulphur Fuel Oil used by the vessel (bottom). Inset shows n-alkanes and isoprenoids pristane (Pr), phytane (Ph) with corresponding ratios.*

Characterisation of the spilled oil showed it to be consistent with VLSFO. A preliminary comparison with the VLSFO used by the MV *Wakashio* confirmed that the oils were similar despite the effects of weathering on the spilled oil. All evidence to data points to the grounding of the MV *Wakashio* in July 2020 to be the first spill of this class of fuel oil. Further on-going analyses will be used to more fully examine the oils.

References

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