The origin and fate of sulphur compounds in petroleum reservoirs as well as the reactivity of \( \text{H}_2\text{S} \) in the presence of hydrocarbons is of increasing interest to petroleum exploration, exploitation, and acid gas sequestration. While direct reaction of mineral sulphur (sulphate, elemental sulphur) with hydrocarbons via thermochemical sulfate reduction has retained much attention in literature, direct reaction of \( \text{H}_2\text{S} \) onto hydrocarbons has been rarely considered.

In order to document \( \text{H}_2\text{S} \)-oil interactions, pyrolysis of oil and model compounds in presence of hydrogen sulphide was conducted in gold cells (330 and 350°C at 700 bar).

Results show the formation of organic sulphur compounds which are very similar to those found in high sulphur petroleum (Figure 1).

In order to better understand the reaction pathways, experiments were run on aliphatic and aromatic model compounds.

The co-pyrolysis of n-octane/\( \text{H}_2\text{S} \) and alkylbenzene/\( \text{H}_2\text{S} \) at 350°C and 700 bar for 7 days lead respectively to thiophene, thiols, thiolanes, alkyl-thiophenes in the first case; thiol-aromatics, phenylthiophenes, alkyl-benzothiophenes in the second. Nevertheless, the selectivity of sulphur compounds represents less than 20% of the products. It was also shown that the presence of \( \text{H}_2\text{S} \) increases the thermal decomposition rate of alkylbenzene, whereas it decreases the decomposition rate of octane in the laboratory conditions. Radical chemistry reaction pathways were proposed to explain the results obtained. The data were compiled into free radical kinetic models. By extrapolation of the kinetic models to low temperature, it appeared that \( \text{H}_2\text{S} \) increases the decomposition rate of both alkanes and alkylbenzenes in the geological temperature conditions.

It is proposed that in petroleum reservoirs, \( \text{H}_2\text{S} \) - hydrocarbons interactions will lead to labile sulphur compounds. Some will react further with hydrocarbons leading to \( \text{H}_2\text{S} \) re-generation. The concentration of \( \text{H}_2\text{S} \) in the system at any moment of the reactions is thus a consequence of the mass balance between consumption and generation. Others labile sulphur compounds will follow a reaction path leading to the formation of more stable aromatic sulphur compounds. Thus, the ultimate fate of \( \text{H}_2\text{S} \) derived sulphur will be sequestration in the petroleum fluid. Further reaction (e.g. dibenzothiophene polymerization) may lead to the incorporation of the aromatic sulphur compounds into pyrobitumen which may act as an ultimate sink for sulphur.
Figure 1A: GC-FID-FPD chromatograms of C₆⁺ hydrocarbons (top) and organic sulfur compounds (bottom) obtained after confined pyrolysis of an oil - H₂S mixture at 350°C and 700 bars during for 7 days. The initial oil did not contain any sulfur prior to the experiment.

Figure 1B: Organic sulfur compounds distribution (GC-FPD) of a high sulfur oil from the Caspian Sea.