# Global oil productivity evaluated from the comparison between sediment production and mantle fluxes

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Hydrocarbons in sedimentary basins can, on a global scale, be considered as that part of the sedimentary production which escaped subduction. That escape must either correspond to passive margins or occur in the early stages of the subduction process because, as shown by experimental studies, once carbon has entered the field of high pressure subduction metamorphism it remains stable throughout down to upper mantle conditions, either as primary carbonate or graphite or as secondary carbonate derived from oxydation of the reduced carbon.

Hence, if sedimentary production and mantle fluxes are reasonably constrained, the global oil and gas productivity can be determined as the difference between sedimentary production and subduction flux.

Unlike some other elements (notably nitrogen) carbon appears to be in a steady state situation for surface mantle exchanges, as reflected by the very uniform isotopic composition of mantle carbon (exotic values correspond to less than 1% of the samples), with an average value at $\delta^{13}C$ ~4‰ (Javoy and Pineau, 1991) Carbon fluxes in both directions, deduced from ridge outgassing are of the order of 1–2 $10^{14}$g Carbon /year. This is significantly less than the estimates of sediment production. The simplest way to explain the difference is through the escape of mobile carbon-bearing phases, both oxidized ($CO_2$) and reduced (hydrocarbons). In order to constrain these fluxes one has to know the proportion of reduced and oxidized carbon both in the sedimentary production and in subduction flux.

The later is readily obtained through the $\delta^{13}C$ of the total subduction flux (−4‰), which corresponds to~ 15% reduced carbon, the total flux being also well constrained at 1.8 $10^{14}$g/year. There is more uncertainty on the sedimentary production. After organic matter diagenesis the fluxes are estimated to between 2 and 2.8 $10^{14}$g/year, (which would correspond to a subduction efficiency of between 60 and 90% ) and a reduced carbon/oxidized carbon ratio between 1:3 and 1:4 according to the relative importance given to shales vs carbonates and their reduced carbon content.With these numbers one obtains oil and gas (including $CO_2$) productivities between 70 and 40%, with fluxes between 66 and 17 million tons/year. Of course the input data, and especially the sedimentary production, have to be refined, but this shows that one can arrive at the evaluation of global resources' productivity. It is also possible to calculate the $CO_2$ flux generated together with the hydrocarbon flux.

In that respect another uncertainty is the so-called mantle contribution, as recognized for example through the existence of $^3$He-rich helium. Up to now the associated $CO_2/^3He$ ratio appears generally very low relative to mantle values so that the mantle $CO_2$ transfer to sedimentary basins appears much less efficient than the rare gas transfer.

## References

Javoy, M. and Pineau, F. (1991) *Earth Planet. Sci. Lett.*, **107**, 598–611.