The Resource “Triangle”

How it applies to conventional and unconventional hydrocarbon accumulation

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Typical Resource Example - Copper

• Copper is an essential modern commodity. Used in wires, semiconductors, pipes, coins and other applications. Excellent conductor of heat and electricity.

• First used by humans about 9000BCE as native copper and later as the major constituent of bronze.

• Today, major ores are mostly sulphides (chalcopyrite, bonite) and are surface mined in huge open-pit operations. A huge amount of energy is required to mine and refine copper.

• Extensive use makes copper a key indicator of the modern economy. The total amount used has increased dramatically in recent years along with the price.
Typical Mineral Resource Distribution

- Cost of extraction increases with decreasing purity of ore
- As purity decreases, the available resource increases
Conventional Hydrocarbon Resource Distribution

• Distribution of conventional hydrocarbons is different to that of other minerals.

• Hydrocarbons derive from an underlying resource of organic rich kerogen trapped in shales, deposited in basins 10-600 million years old.

• Only a tiny proportion of kerogen ultimately becomes hydrocarbons trapped in conventional reservoirs because:
  1. Thermal maturation (cracking) needs to take place in the source rock;
  2. Hydrocarbons then have to find their way out of the source rock;
  3. Porous reservoirs have to be adjacent or above the source rock;
  4. A vertical permeability seal must be present above the porous reservoir.

• When all these criteria have been met then a highly concentrated accumulation of hydrocarbons is created. This is rare.

• These circumstances result in an inverted distribution where the largest resources are the easiest and cheapest to find, and have the lowest cost of extraction.
Large fields contain a disproportionate amount of resources, and an even more disproportionate amount of net energy.

The number of fields and their size in any given basin follows a statistical distribution which is the basis of ‘peak oil’ calculations.
Unconventional Hydrocarbon Resource Distribution

- Distribution similar to other minerals.
- However the economic limit is not determined just by price but by the net energy gained.
- The key to understanding this resource is the EROEI.
- Most unconventional resources will never be economic because the energy expended to create them is greater than the energy extracted.
Conclusions

• The distribution and economics of conventional hydrocarbons is very different from the unconventional or resource play hydrocarbons.

• Wall Street does not understand this.

• The present audience is much better informed!