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Environmental Innovation and Societal Transitions

journal homepage: www.elsevier.com/locate/eist



Recognising the Second Half of the Oil Age



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ARTICLE INFO

Article history:

Received 23 August 2013

Accepted 28 August 2013

Available online 21 October 2013

Keywords:

Depletion

Human history

Oil Age

Petroleum

ABSTRACT

Technological developments saw radical progress over the past two centuries in the so-called *Industrial Age*, which made new demands for energy from coal and petroleum. But they are natural resources formed in the geological past which means they are subject to depletion. Determining the current status of depletion is difficult, both because of unreliable reporting practices and definitions, and because the definition implicitly depends on the future state of technology, which cannot be known accurately. But the evidence available today suggests that the Second Half of the Oil Age is dawning. It will be characterised by dwindling supply, with rising costs, representing a turning point for mankind, but much can be done to react positively.

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1. Introduction

The Solar System was formed almost five billion years ago and included Planet Earth, having a molten core, a viscous mantle, and a hard crust surrounded by a thin skin of air and water, forming the atmosphere and the oceans, essential to life. The continents moved around on deep-seated convection currents, forming rifts where they separated and mountains where they collided. Seas and lakes became home to early forms of life more than 550 million years ago. Some species, such as the limpet (or *Patella* to give it its scientific name), have remained little changed, but others evolved where they found a niche that suited them, only to die out when it closed from natural causes, including massive volcanic eruptions, climate changes and meteor impacts.

Homo sapiens made an appearance about 200 000 years ago, and settled agriculture followed about 12 000 years ago bringing what could be called *Modern Man*. Food had to be stored between harvests

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which in turn prompted trade, finance and the development of managed communities. The fertility of the lands was however subject to depletion causing the community to conquer other lands or face near extinction. *Stone Age Man* had used flints before people turned bronze, iron and steel for better tools and weapons. Smelting called for fuel, coming at first from firewood and charcoal and then coal dug from outcropping seams. The pits were progressively deepened into regular mines, and minerals were extracted in a similar way.

But the mines were subject to flooding when they hit the water-table, which prompted a remarkable technological progression. The hand pump gave way to the steam pump which in turn evolved into the steam engine. Then in around 1870 a German engineer by the name of Nikolaus Otto, perfected a method of injecting the fuel directly into the cylinder leading to the *Internal Combustion Engine* which was much more efficient. At first, it used benzene distilled from coal before turning to petroleum refined from crude oil.

These technological developments, fuelled primarily by easy energy from coal, oil and gas, led to the so-called *Industrial Age* which opened about two centuries ago. The rapid expansion of industry, transport, trade and agriculture allowed the human population to expand tenfold from about 600 million in 1800 to its present level. The first automobile took to the road in about 1880, and the first tractor ploughed its furrow in 1907.

But oil is a finite natural resource, formed in the geological past under special conditions and thereby subject to depletion, which in turn implies that there is an *Oil Age* with the First Half being marked by expansion and the Second Half by a corresponding contraction. Indeed, history shows that this is a natural pattern as empires have waxed and waned throughout time. Trade and associated financial control, carrying serious political implications, have been key features of empires.

The evidence suggests that we are now about half way through the *Oil Age*. Assessing the status of depletion is a difficult task because public data on discovery are unreliable, and there is also much confusion over the definition of the different categories of oil and gas, each having its own characteristics. It is accordingly worth examining these issues in greater detail.

2. Petroleum geology

It did not take long for the pioneering oil explorers to realise that discovering a viable oilfield depended on identifying a place where geological source-rock, reservoir, trap and seal came together. At first, they relied on technology no more advanced than the hammer, hand lens and notebook as they mapped the outcropping rocks, but later came ever more sophisticated geophysical and geochemical techniques to map the subsurface in detail.

It transpires that much of the world's oil comes from two epochs of global warming, 90 and 150 million years ago. Algae proliferated in the warm sunlit waters of lakes and seas in restricted rifts, and the organic remains sank to the depths where they were preserved in anoxic conditions caused in part by the lack of circulation due to the warmth of the surface waters. These rifts were progressively filled with sediments washed in from the adjoining lands, and when the organic material, known as *kerogen*, was buried to a depth of about 2000 m it was heated enough to be converted into petroleum. The *kerogens* yield oil or gas depending on their precise composition, with the oil being also converted into gas by high temperature on deep burial. Once formed, the oil and gas began to migrate upwards through the rocks. Fractures formed a common migration path although so-called *carrier-beds* having high porosity and permeability facilitated the movement, sometimes over long distances, even reaching the surface. The massive tar-sands of Canada are a well known example.

The migrating oil and gas was locally trapped in dome-like geological structures, known as anticlines, provided that such held porous reservoirs and were covered by an effective seal of clay or salt. Sandstones form the most common reservoir although fractured limestones are also locally productive.

3. Petroleum history and politics

Oil and gas from surface seepages have been known from the earliest of days, but the birth of the industry is generally attributed to a discovery in Pennsylvania in 1857. At first it supplied lamp oil that was becoming short from the depletion of whale oil, but the arrival of the internal combustion engine

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