THE CLEAN-COAL DELUSION

Reg Morrison

All coal mining, whether deep-shaft or open-cut, is responsible for releasing significant quantities of carbon into the atmosphere. The common belief is that the major part of this emission comes from power-station chimney stacks. In fact it occurs long before the coal is burnt. Significant volumes of methane (CH_4), and small quantities of carbon monoxide (CO), carbon dioxide (CO_2), sulfur dioxide (SO_2) and nitrogen oxides (NO_X) are released into the atmosphere whenever an underground coal seam is breached or the overburden is removed. Although the volume released is very difficult to assess and varies considerably from mine to mine, conservative estimates suggest that this process alone usually releases at least as much carbon into the atmosphere as does the burning of the extracted coal, and perhaps much more. The gas content (97% methane) of Queensland coal seams usually ranges between 4 and 10 cubic metres per tonne, but may be up to 15 cubic metres per tonne in some places. Some coal seams are so rich in these potent greenhouse gases that mining is impossible without first purging them of some of their methane.

The methane and carbon dioxide embedded within a coal seam is generally not the gas that was produced during the initial decay of the vegetation that formed the coal. Some of the gas is produced by heat and pressure during the natural process of coalification, but most gas is the biogenic waste that is discharged by the coal-eating bacteria that infest the seam whenever water is present. There are coal seams in Australia that are up to two thirds water by volume (67%!) and barely warrant the label ‘solid fuel’. Where the water content is high, the methane content is similarly high due to the density of methane-generating bacteria that thrive in such wet, carbon-rich, oxygen free habitats. If the water in these seams is extracted by pumping, or the coal is exposed to air during mining, it releases most of the methane that clings to its interstitial surfaces and the gas migrates easily along the seam. Such permeable seams discharge large quantities of methane until most of the coal bed dries out.

The bulk of the world’s coal mines are open-cut however, and it is these that pose by far the greatest greenhouse threat to the planet.[1] The act of exposing a coal seam to the air inevitably releases the embedded gases and then allows the exposed coal to generate additional CO_2 as it oxidises and decays. Meanwhile, the volume of overburden that is removed during open-cut mining may constitute up to 10 times the volume of the mined coal, and this overburden material, dumped as tailings, inevitably contains a considerable percentage of coal dust, low-grade coal, and carbon-rich shale—up to 50% in some cases. This carbon too, gradually oxidises on contact with the interstitial air in the tailings, releasing still more CO_2.

Deep-shaft mine tailings that are unfit for use in power generation have a similar carbon content and gas problem. Gas from mine tailings adds significantly to other above-ground emissions that come from the mine’s heavy machinery, and from the production of electricity to light and run the mine and its offices, day and night, seven days a week. Added to this are emissions from vehicles used by the management and its commuting workforce, as well as emissions associated with the company’s city offices and advertising initiatives.

When all these unmeasured and uncontrollable ‘fugitive emissions’ are added together the total greenhouse impact of such mining activity probably equals, and perhaps exceeds, the greenhouse potential of the mined coal that is eventually burnt in a power-station furnace. and the 80–90% carbon capture promised by geosequestration will only amount to somewhere between 5% and 10% of the greenhouse gases already released during mining and transportation of the coal.

Deeper coal seams tend to contain more methane than shallow ones on a tonne for tonne basis, since some of the methane that is embedded in and around shallow seams tends to leak out over geological time. However, the extensive exposure of coal in an opencut mine and the loose dispersal of the carbon-rich overburden as tailings ensures maximum methane release.

Blasting initiates an extensive pattern of micro-fractures throughout the surrounding strata and thereby releases most of the methane that was trapped there. Methane plumes arising from opencut mines have been recorded, although accurate measurement of the volume and precise source (exposed coalface or tailings) is virtually impossible. One Australian study in 1993 found that there was little or no gas to be found in freshly uncovered coal, nevertheless there was a plume of CH_4 emanating from the opencut mine itself. "This … resulted in estimates of emission factors for Queensland of 2.2 cubic metres of CH_4 per tonne of coal whilst for the Hunter Valley mines, the specific emission was about twice as large."[2]

Air measurements at several Australian underground mines have shown that they yield about 4 times more methane than is contained within the coal seam itself.[2]

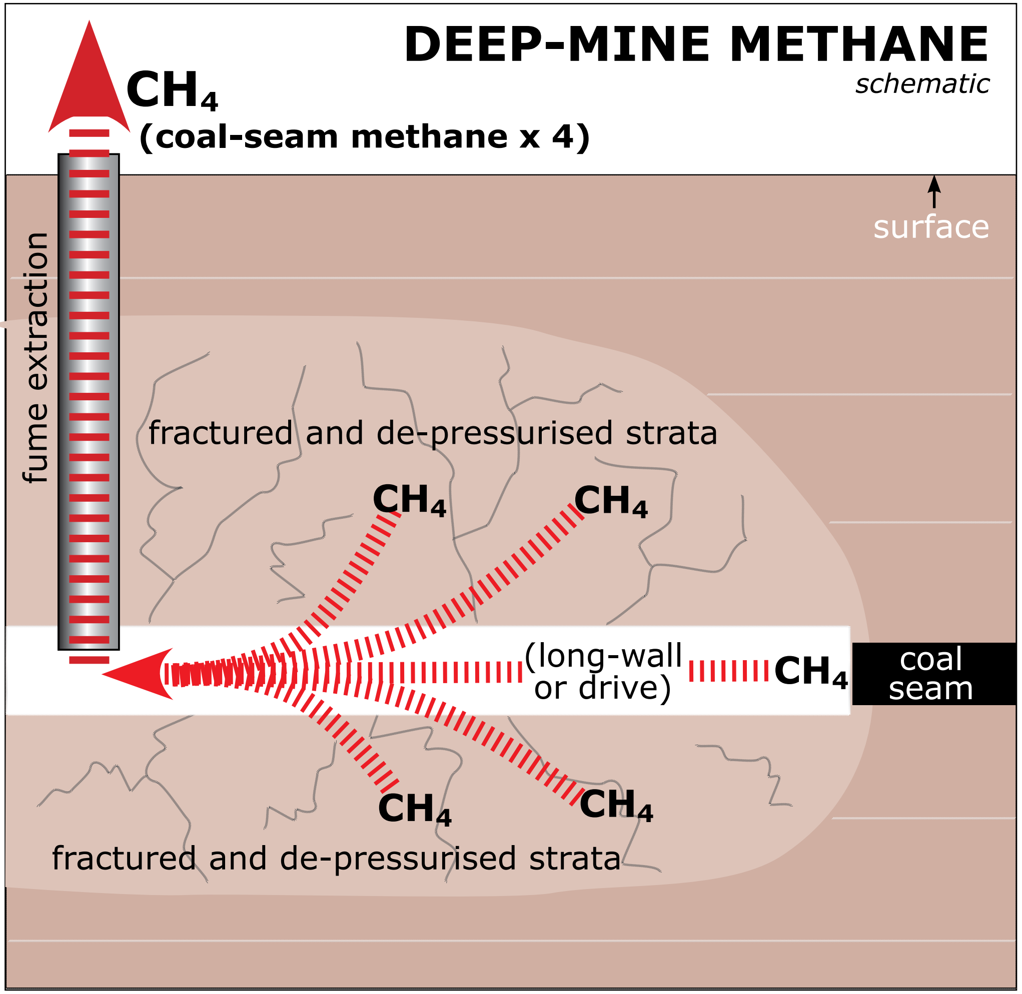
At present, almost all deep-mine air is vented directly into the atmosphere and very few mines siphon off this rich source of methane for injection into combustion engines to aid power generation. An American study in 1997 found that the world's underground mines alone emitted at least 32.2 billion cubic metres of methane annually.[3]

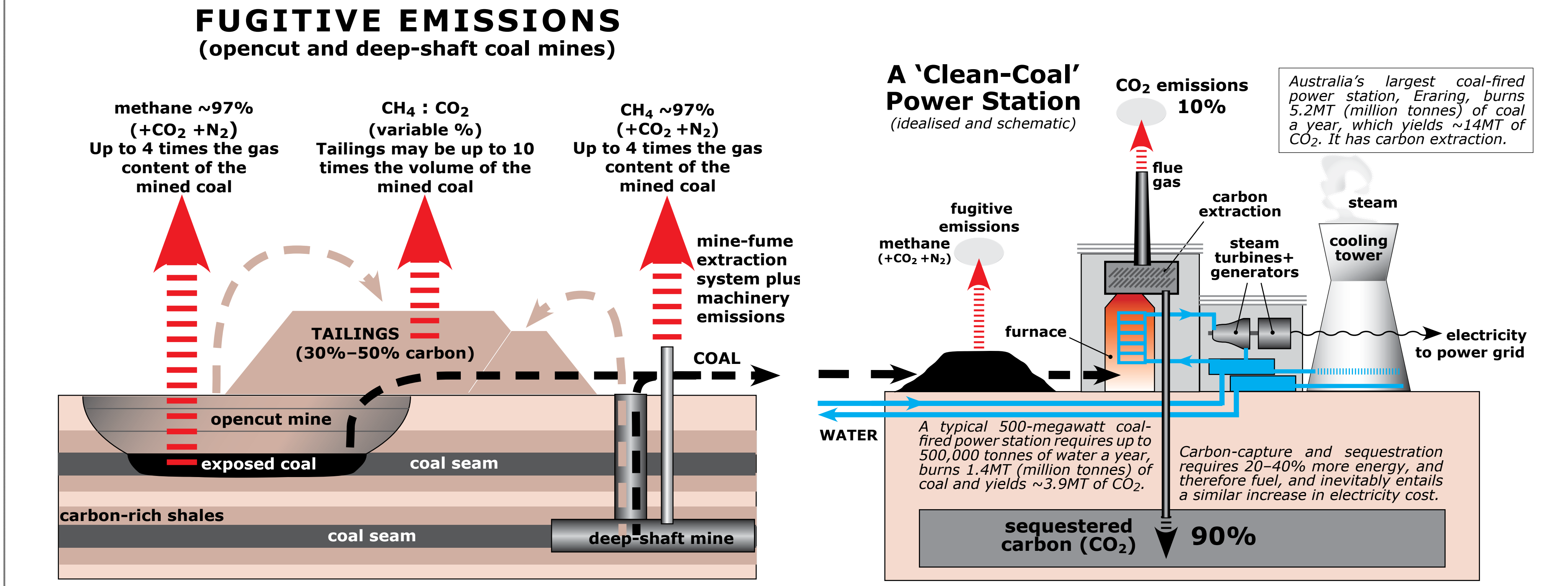
NOTES

1. Australia, one of the world's leading coal exporters, has at least 118 black-coal mines in current operation, of which more than half are opencut. A few deep-shaft mines also have an opencut component.

2. "Fugitive Emissions from Coal Mining." Reported in a 1999 paper by The Australian Academy of Technological Sciences and Engineering.

3. Saghafi, A., Williams, D. J., and Lama, R. D., 1997. "Worldwide methane emissions from underground coal mining." In the Proceedings of the 6th International Mine Ventilation Congress, Pittsburgh, PA, USA, pp. 441-445.





The volumes shown in this diagram are approximations and vary from mine to mine, however, such on-site sequestration of carbon as shown in the power station is rarely practicable and additional CO_2 emissions are commonly incurred by transporting and sequestrating the CO_2 elsewhere. While coal-seam gas is predominantly methane by volume, any methane that remains in the fuel coal when it goes into the furnace is oxidised and becomes part of the general CO_2 emission when it is burnt. The combustion of one tonne of high-quality coal may yield up to 2.8 tonnes of carbon dioxide, and while burning coal in power stations thereby entails a significant greenhouse-forcing factor, its consequence is significantly enhanced by the methane and CO_2 released by mining the coal in the first place.

It is also essential to remember that the greenhouse impact of the fugitive emissions from the mine are magnified by the fact that methane has more than 100 times the greenhouse-forcing potential of carbon dioxide during its first 5-7 years in the atmosphere. (This average forcing factor reduces over a period of 100 years to about 20-23 times that of CO_2, yet this misleading reference is the one that is most often quoted).

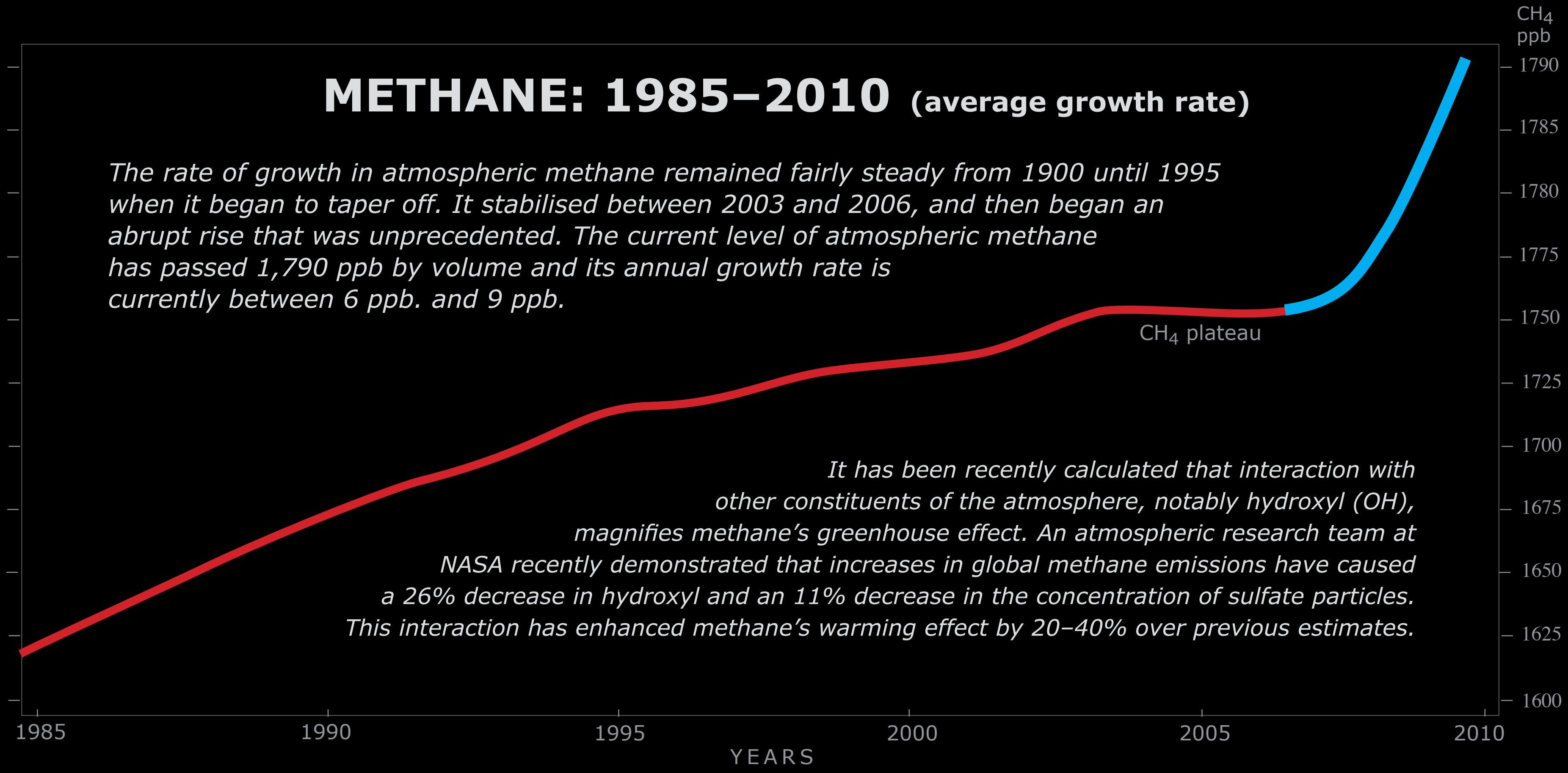
There is a second major coal-mine pullution factor that is never mentioned in public: the fly-ash collected by the carbon extraction process in the flue of a modern coal-burning power station is up to 100 times more radioactive than the waste from a nuclear reactor. Geosequestration places that waste within the reach of groundwater.

Scientific American, 13/12/07 (www.sciam.com/article.cfm?id=coal-ash-is-more-radioactive-than-nuclear-waste.)

"Where the water content is high, the methane content is similarly high due to the density of methane-generating bacteria that thrive in wet, carbon-rich and oxygen free habitats."

PHOTO: Reg Morrison

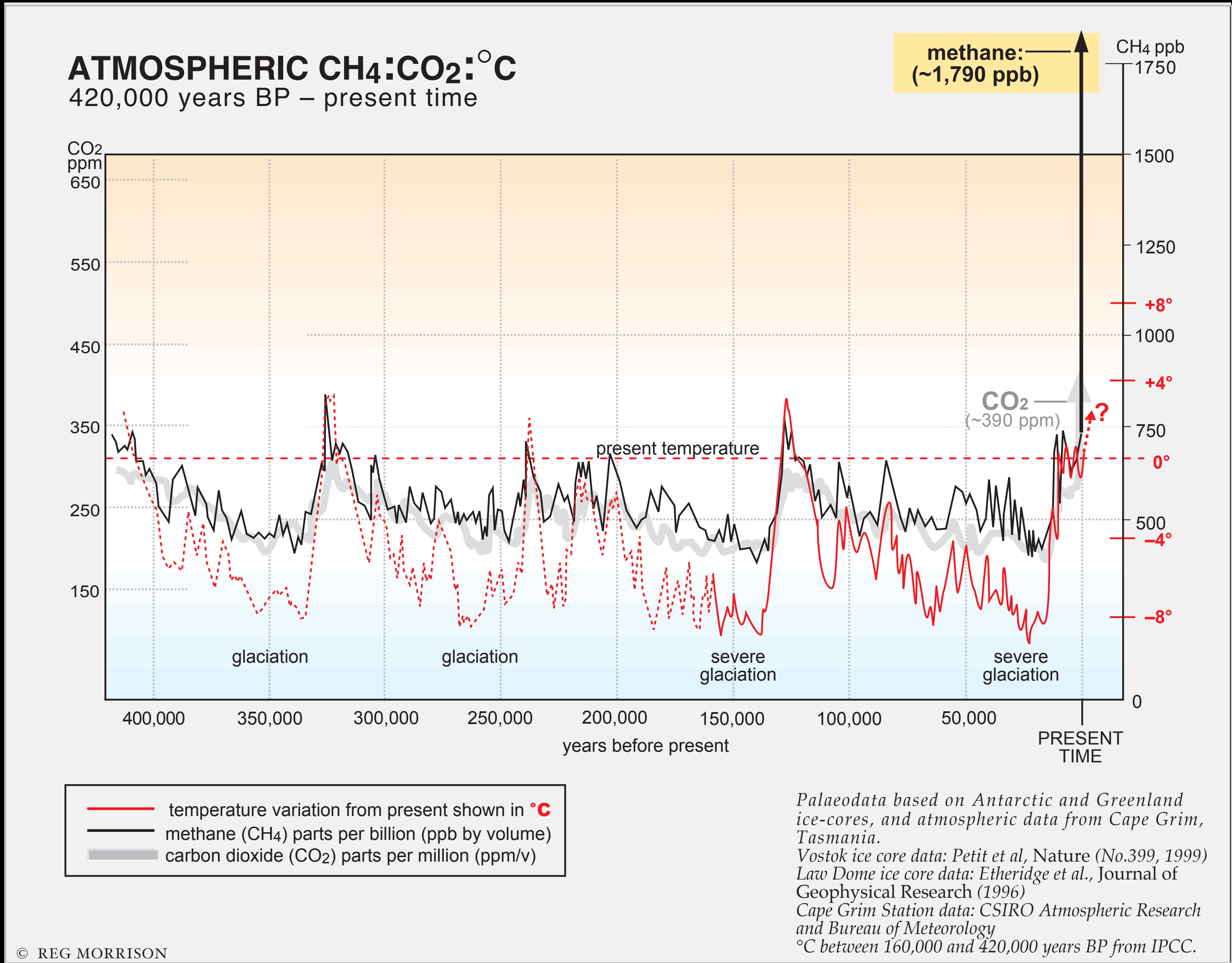
This picture was taken at the Hebe coalmine near Collie in south-western WA in 1965, after an aquifer that overlay the coal seam was accidentally breached. The flooded mine never reopened. With few exceptions, methane-rich coal seams lie below the regional water table and are permeable.



The volume of methane in the atmosphere has grown fairly steadily since the beginning of the modern industrial era (~1750) when it was only about 680 ppb. When the daily rate of methane decay finally caught up with the increased rate of injection in 2003, the level stabilised for almost four years. Towards the end of 2006 however, the methane level began to surge again (shown in blue). This now appears to be due to the accelerating disintegration of marine and tundra hydrates. Climatologists at NASA's Goddard Institute for Space Studies now believe that methane may account for up to a third of the global warming from greenhouse gases between 1750 and today.[1]

According to this new research by NASA scientists, the impact of methane on the Global Temperature Index may be almost double the amount that was previously attributed to this gas.

1 Drew T. Shindell, Greg Faluvegi, Dorothy M. Koch, Gavin A. Schmidt, Nadine Unger, and Susanne E. Bauer
Science 30 October 2009 326: 716-718 [DOI: 10.1126/science.1174760]



From an evolutionary perspective 'Clean Coal' therefore appears to be just another human delusion, a seductive pipe-dream that will do little more than increase our energy consumption, accelerate global warming, and greatly hasten the collapse of the fragile environment that supports our energy-hungry species.