Critical Review of World Uranium Deposits and Resources for the 21st Century

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In 1999 nuclear reactors burned 61 500 tonnes uranium (tU) to generate about 16% of the world electricity supply. A recent study supported by the World Energy Council defines a wide range of possible future nuclear power use. Cumulative uranium requirements to 2050 for the low, mid and high cases are, respectively 3.390, 5.350 and 7.580 million tU. An analysis of uranium supply prepared by the International Atomic Energy Agency gives a compilation of non-production supplies, Known uranium resources and estimated Undiscovered resources sufficient to supply reactors to 2050. To 2020, production from mines will be supplemented by existing civilian inventories, blended down warhead material and other sources. For the mid case, about 75% of demand to 2020, and 90% to 2050, would be met from mine production. An increased proportion of mine output is required for the high case. This paper discusses the uranium deposit types (with associated production costs) that could fuel nuclear power in the 21st century, under conditions of mid to high growth. Important deposit types are those with large resources producable at low to medium cost. The production costs of the various deposits range from ≤\$13.00/lb U_3O_8, to >\$50/lb U_3O_8 Base load production is from the giant, high grade unconformity-type deposits in Canada, very large, medium grade Australian unconformity-type deposits, and the giant Cu-U-Au breccia complex Olympic Dam deposit. Sandstone-type deposits amenable to ISL recovery are also important. Production from sandstone deposits is limited by their small average size. Known, higher cost resources will also be mined to meet demand, unless exploration discovers new low cost deposits. Uranium by-product from phosphate production and recovery from sea water could also provide large supplies at medium and high cost, respectively.