McConnell Club

2012-2013

Lecture Series Schedule
(Last Updated: November 30, 2012)

Please note changes to regular time and room number noted in bold

WINTER 2012/2013

DATE: Wednesday, December 19, 2012, 10.00 AM, Rundle Room

SPEAKER: **K. Udo Weyer, WDA Consultants Inc., Calgary; weyer@wda-consultants.com**

TITLE: **Effect of groundwater dynamics on the occurrence of thermal areas and geysers in Yellowstone National Park**

Up to the late 1960s, groundwater recharge for the geysers in Yellowstone National Park was thought to be from the nearby rhyolite plateaus, such as the Madison Plateau, the Central Plateau, and others. The application of deuterium, oxygen, and chlorine isotope studies then resulted in the birth of a new concept caused by measured and back-calculated isotope values. The observed isotope differences between isotope measurements in shallow boreholes (up to 300 m) and that of young shallow meteoric water were on the order of 5 •D. These observations initiated the development of a new concept whereby the recharge of the deep groundwater was to have taken part at colder temperatures either in the high areas of the Gallatin Range or dating back to the Pleistocene (2,588,000 to 11,700 years ago). Yellowstone National Park was covered by ice caps/glaciers on two occasions: (1) about 150,000 years ago at the height of the Bull Lake glaciation (covering much of the West Yellowstone Basin), and (2) about 17,000 to 20,000 years ago at the peak of the Pinedale glaciation (covering much of the park).

By applying various methods it has been argued that only 0.2 to 3% of the discharged groundwater originated in the deeper crust close to magma present at a depth of about 5 km. The other 97+% have been recharged at the surface, penetrated to depth (shallow or deep), and subsequently ascended to the surface and discharged as hot springs and geysers. Hydrograph base flow evaluations of the Firehole and Gibbon Rivers indicate that the groundwater discharge in their catchment basins would be approximately 7.5 m3/s and 2.5 m3/s respectively. Transmission of these amounts through major fault zones only (as is often assumed) does not appear to be feasible for two reasons: (1) the large amount of flow, and (2) the role of groundwater dynamics. An assumption of recharge from the ice sheet would be improbable as any water movement within the ice sheet would likely concentrate on the deeper parts of the sheet. The valleys in the rock topography would concentrate groundwater flow within the ice sheet. Flow times of several thousands of years are not unusual for long range and deep flow systems such as those which recharge from the plateaus and may have taken a long time to reach present day discharge areas in dependence of the permeabilities and hydraulic gradients involved. The cold climate interval during the middle ages has also been considered as a time of recharge of colder water with the appropriate isotopic fingerprint.

Water temperatures at greater depth will be in the range of 370oC under a pressure of 25 MPa (250 bar) or more. These conditions are close to the critical point of water where water exists as liquid, supercritical fluid and as vapour. The supercritical fluid (assumed to be 0.2 to 3% of the total discharge at surface) may contain an isotope imprint which, upon mixing, may change the total isotope imprint in an unknown manner. To our knowledge there have not been any isotope studies done on supercritical water nor on any mixing at these high temperatures. We argue that the isotope studies have not put sufficient light on the recharge mechanisms for deep groundwater in the geyser areas of Yellowstone National Park. In fact the proponents used geologic reasoning to assume simple groundwater systems which can neither be supported by Continuum Mechanics (Bear, 1972) nor by Hubbert's (1940) Potential Theory.

We will show by graphical representations of the groundwater dynamics involved how the application of Hubbert's Potential Theory and Groundwater Flow Systems Theory leads to an improved understanding of the role of groundwater in the occurrence of thermal areas and geysers. In the area of silica dominated dissolution processes (Upper, Midway and Lower Geyser Basins) and other dissolution processes (Norris Geyser Basin) permeabilities are continuously enhanced by heated water flow thereby improving the effectiveness of both shallower and deep regional groundwater flow systems. The groundwater recharge calculated from base flow and surface catchment areas to the groundwater flow systems exceeds 350 mm precipitation per annum for the Firehole River basin and 270 mm precipitation per annum for the Gibbon River basin and may locally be considerably higher.

We argue that the concept of recharge on the adjacent plateau mountains into shallow and deep groundwater flow systems and the application of modern gravitational groundwater dynamics is a simple, straightforward, and physically consistent explanation for the occurrence of discharge in thermal areas of the Yellowstone National Park, within and outside of the reach of the present Yellowstone caldera. The systems are not driven by convection or buoyancy forces as is often assumed. The application of gravitational groundwater dynamics withstands the necessary and unforgiving test of physical causality in applying groundwater flow to geological processes.

Please note that we have lots of unused Wednesdays after January 16. New talks are welcome!

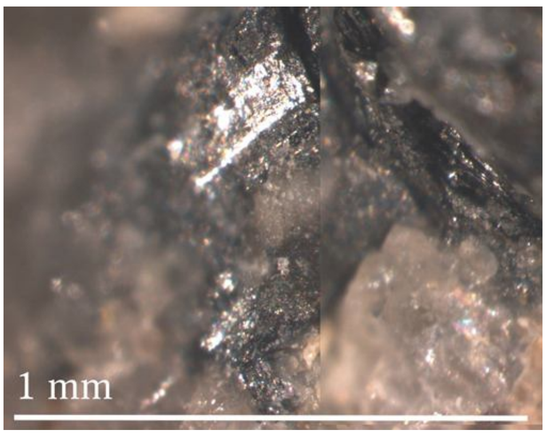
WINTER 2012/2013

DATE: Wednesday, January 09, 2013, 10.00 AM, Rundle Room

SPEAKER: **Wm (Bill) R Howard, President, Clarke Gold Inc, wm.howard@shaw.ca**

TITLE: **CLY Project from micro- to map-scale: 'new' gold-associated Bismuth Telluride minerals located by a re-activated crustal-scale fault. Poly-deformed structures with non-standard names in the southern Kootenay Arc, south of Nelson B.C.**

CLY Project from micro- to map-scale: 'new' gold-associated Bismuth Telluride minerals located by a re-activated crustal-scale fault. Poly-deformed structures with non-standard names in the southern Kootenay Arc, south of Nelson B.C.



Hundreds of micron-sized native gold grains align along cleavage planes as inter-lamellar 'gold trails' in joséite–B. Crystal form is hexagonal, white is qtz

A curving shear of the Mt Proctor Transect Shear Zone with three structures. Host is argillaceous metaquartzite of the HCA Quartzite + Tuff Unit, H. Little's enigmatic and uncorrelated 'Carboniferous sediments' CS unit (1965).

Several gold-associated bismuth (sulpho)telluride minerals and some 'new' uncharacterized phases are first found in the Western Hemisphere and in Canada on CLY Project BC: ikunolite Bi3S4 ingodite Bi(Te,S) and unnamed Bi2Te. Characteristic features allow for field identification collectively as 'bismuth tellurides'. Microphotos of individual minerals have unique textures (N. Cook 2006) supporting non-hydrothermal deposition of gold (left photo).

These rare gold-associated Bi-Te-S minerals occur in qtz veins 500 meters from the Tillicum Fault 'TF' (J. Einarsen 1991) a major, crustal scale fault with ultramafic pods (serpentinites, wehrlite, pyroxenites). It has a long history of reactivation. Related shears like the Mount Proctor Transect Shear Zone (right photo) allow the structures to be interpreted.

A recent SHRIMP U-Pb date on biotite granite (B. Davis 2008) supports M. McMechan's (2010) 'Vulcan Low in the Kootenay Arc' hypothesis that at the district scale an underlying Precambrian structure influenced the siting of the TF. It is the boundary between ancestral North America and transported terranes, but unrecognized. Are there similar oft-reactivated major structures in the Cordillera that might locate economic mineral deposits?

How does extreme tourmaline alteration of mid Cretaceous granite and gold - silver - bismuth - tellurium - tungsten deposition relate to the 'Vulcan Low'? Standard terms for structures like the TF would assist mineral exploration in Canada by designating their nature on geologic maps. Is the TF a re-activated fault / accommodation zone / crustal break or tectonic suture zone? Some faults are more faulty than others.

Please note that we have lots of unused Wednesdays after January 16. New talks are welcome!

WINTER 2012/2013

DATE: Wednesday, January 16, 2013, 10.00 AM, Rundle Room

SPEAKER: **Dale Issler, GSC Calgary, DIssler@nrcan-rncan.gc.ca**

TITLE: **Thermal History Analysis of the Beaufort-Mackenzie Basin**

DATE: Wednesday, January 16, 2013, 10:00 AM, Rundle Room

An integrated thermal history study of the Beaufort-Mackenzie basin of northern Canada is underway using multi-parameter data gathered as part of a twelve year petroleum systems research project. New and legacy percent vitrinite reflectance (%Ro) data for approximately 81 wells have been compiled and standardized in order to make maps and cross sections showing thermal maturity trends and to provide paleotemperature constraints for thermal models. Data were quality-assessed by comparing measured %Ro values with other temperature-sensitive indicators (Rock-Eval pyrograms, liptinite fluorescence, and degree of apatite fission track (AFT) thermal annealing) and inconsistent legacy %Ro data were reinterpreted in conjunction with new sample analyses. Extensive organic matter recycling is the major issue affecting data quality and interpretation whereas other factors such as sample caving and oil staining (%Ro suppression) are important but less significant. Multi-kinetic AFT thermochronology data were obtained for 60 (mainly core) samples from 25 key wells with standardized %Ro data to provide constraints on the timing and rates of burial and exhumation across the study area. Also, thermal maturity and shale compaction trends were used to estimate net erosion magnitudes related to multiple phases of Tertiary deformation and exhumation.

Measured %Ro is highest in exhumed strata along the southern basin margin and lowest in thick Cenozoic strata offshore (north) on the Beaufort shelf. Thermally immature strata persist to depths of > 4 km and to temperatures > 100ºC on the outer Beaufort shelf due to rapid deposition of the thick (> 2.5 km) Plio-Pleistocene Iperk Sequence. Shale compaction trends suggest that 0.5-2 km of postrift Tertiary strata have been eroded from southern and southeastern onshore areas. %Ro-based erosion estimates are more variable and can give much higher values (by a factor of 3 or 4) than the compaction-based estimates, particularly in the Tertiary fold belt of the western and southern areas of the basin. There is a discontinuous increase in maturity across the unconformity that separates Jurassic synrift and Permian prerift strata along the southern basin margin. In the area south of Richards Island, maturity trends suggest that up to 4 km of Permo-Triassic strata may have been eroded prior to the deposition of Jurassic sediments. In the Anderson Plain to the east, erosion has been more extensive and Devonian rocks lie near the surface. Thermal modeling of AFT data from a Devonian sample in the Kugaluk N-02 well (AFT age: 216 Ma) suggests that exhumation was well underway in the Triassic, possibly in association with the onset of rifting. Exhumation may have continued until the Early Cretaceous, followed by reburial under 1-2 km of Cretaceous-Cenozoic sediments that were removed subsequently by erosion. The %Ro data provide important maximum paleotemperature constraints for integrated thermal history models based on multi-kinetic, AFT thermochronological data collected for the synrift and postrift successions.

Please note that we have lots of unused Wednesdays after January 16. New talks are welcome!

For more information: Pavel Kabanov (GSCC), Room 212, Pavel.Kabanov@rncan-nrcan.gc.ca