Tiny bubbles a storehouse of knowledge

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Fluid inclusions – tiny bubbles of fluid or vapor trapped inside rock as it forms – are clues to the location of ores and even petroleum; and they are time capsules that contain insights on the power of volcanoes and hints of life in the universe.
But the realization of the scientific value of fluid inclusions is relatively recent.

At the Centennial Celebration Symposia for the Society of Economic Geologists, Virginia Tech Distinguished Professor of Geosciences Robert Bodnar will review the history of the scientific uses of fluid inclusion, identify the big questions that remain to be addressed, and predict the state of the field in 10, 50, and 100 years.

The title of his paper is "Fluid inclusions, from H.C. Sorby to Edwin Roedder and Beyond."

Fluid inclusions were considered curiosities until Sorby saw the mineral-incased bubbles as clues to processes that create rocks and minerals. Sorby, a pioneer in the use of the microscope to examine rocks, was the first to describe inclusions from a scientific perspective. In 1858, he used them to determine the temperature and pressure at the time the rock was formed.

"Not much else was done until Ed Roedder applied inclusions to wide range of geological problems," Bodnar said. Roedder showed that inclusions could be tapped to determine the pressure and temperature at the time of formation. Roedder's definitive book, Fluid Inclusions

(1984), described what fluid inclusions are and how they can be used. Now 86 and still active, Roedder was Bodnar's mentor at the U.S. Geological Survey and continues to provide valuable advice and support today.

Fluid inclusions are a timely topic. They are used by the oil industry to predict where oil deposits have occurred and to track where oil has flowed through the subsurface in order to discover new fields. Chevron hired Fang Lin, one of Bodnar's recent PhD students, to help with exploration because of her experience with fluid inclusions.

But fluid inclusions are really most valuable to exploration for metal deposits, such as copper, gold, and lead. Certain types of fluid inclusions are located with certain types of ore.

"We slice the rock, and if you see inclusions with certain characteristics, it tells us what we are likely to find," Bodnar said. Which leads to the questions that remain to be addressed. "The biggest uncertainties are how long it takes for an ore or petroleum deposit to form," Bodnar said. "Does it take hundreds of years, thousands of years, or millions of years?

"We know how long some processes are active. We know some metal deposits formed in an environment similar to an active volcano. Two or three miles under Mount St. Helens is the kind of environment where copper deposits form," Bodnar said. "The Bingham Canyon Mine, one of the world's largest surface mines, was once under a volcano."

But how does ore form in the volcano? "Volcanoes can be dormant hundreds or thousands of years. Mount St. Helens has been active only a few months in the last 25 years, for example," Bodnar said.

He is part of a group that is studying Mt. Vesuvius. "Written records that go back thousands of years provide a historical record regarding when

eruptions occurred, how long they lasted, and how long the volcano was dormant. We are able to extract fluid from the inclusions and use isotope techniques to determine the age when it was trapped," Bodnar said. "We can compare that with the written records and then know what the volcano was doing as the ore formed.

"The better we understand how deposits form, the better able we will be to develop techniques to look for new deposits. There are millions of old, dead volcano sites. They didn't all form ore deposits. The inclusions from the ones that did will tell us what to look for," Bodnar said.

But his favorite future use of fluid inclusions is to study the universe. The rock-bound bubbles are clues to whether there was once water, and possibly life, among the stars. "If we have rock samples from Mars and we find inclusions with water, it increases the chances that there could have been some form of life," Bodnar said. Fluid inclusions will be an important tool to study meteorites and rocks from the moon, asteroids, and the planets we will visit to look for evidence of water and the possibility of life."

The symposium is Saturday, Oct. 15, during the Geological Sciences of America national meeting in Salt Lake City Oct. 16-19. The society has asked the world's experts in areas of economic geology to give talks summarizing the state of their fields. As the Society of Economic Geology Distinguished Lecturer, Bodnar was asked to give the keynote address.

Source: Virginia Tech