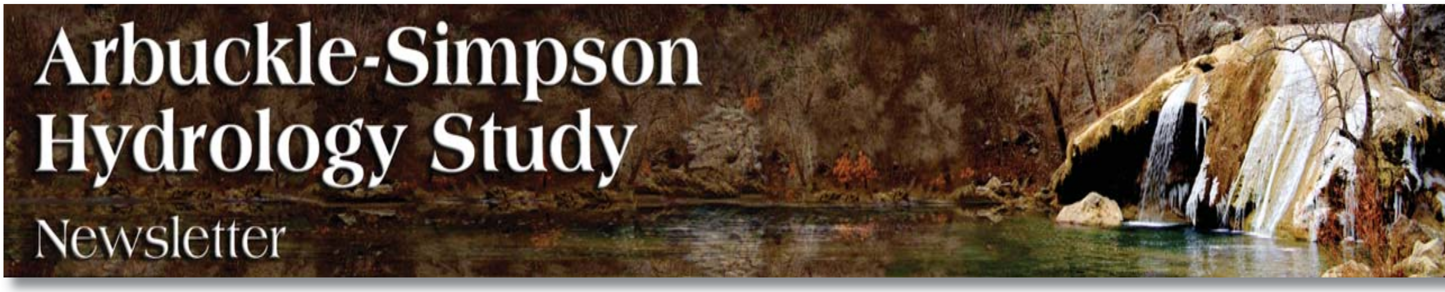
Arbuckle-Simpson Hydrology Study Newsletter



THE OKLAHOMA WATER RESOURCES BOARD — March 2007

Helicopter to Fly Over Arbuckle-Simpson Aquifer

Don't panic if you see a helicopter flying over the Arbuckle-Simpson aquifer region with a torpedo-like device dangling in the air. The helicopter and its cargo are just some of the tools being used to study the aquifer. The torpedo-like object is actually a sensor that sends out low-power electromagnetic waves that penetrate the earth and reflect off rocks to create a picture underneath the ground. Similar to a medical CAT scan, data obtained from the helicopter electromagnetic and magnetic (HEM) survey can be used to produce subsurface images of the electrical structure of the earth. According to Dr. Bruce Smith, a geophysicist with the U.S. Geological Survey, researchers can see much more detail of the earth's subsurface than ever before by using this technology.

Helicopter and sensor during a previous study

The goal of the geophysical study is to help researchers better understand the faults and subsurface features and how they may affect groundwater flow through the geologically complex Arbuckle-Simpson aquifer. The HEM data will be integrated with other geophysical and geologic information into a three-dimensional geological model being constructed by USGS scientists Dr. Charles Blome and Jason Faith. The USGS used a similar survey to identify unmapped faults in the Edwards aquifer of south central Texas. HEM data from that study are providing critical information to the geologic and hydrologic flow models of the Edwards aquifer.

The helicopter flights, which will be operated under contract with the USGS, are scheduled to begin in mid-March. The survey will cover three target areas in the eastern portion of the aquifer, referred to as the Hunton Anticline. Each area is about the size of a township (36 square miles). The sensor, which researchers stress is of no threat to the public, will be flown about 100 feet off the ground in rural areas near Sulphur, Mill Creek, Pontotoc, Connerville, Hickory, Roff, Bromide, and Fittstown.

The study is being funded by USGS in cooperation with other state and federal agencies, such as the Oklahoma Corporation Commission, which is contributing additional funds to map possible underground salt-water contamination in nearby oil fields.

The helicopter and sensor prior to take-off

Arbuckle-Simpson Hydrology Study Update

The Arbuckle-Simpson study is now in its fourth and most important year. Our talented team of federal, state, and university researchers has made considerable progress in obtaining information necessary to meet our goal, which is to determine the amount of water that can be withdrawn from the aquifer without reducing the natural flow of springs or streams.

The first three years of the investigation were focused on monitoring and evaluating various aspects of the aquifer system, such as groundwater and surface water flow, the hydrologic budget, and the geologic framework. This year, we will focus on developing groundwater and surface water models and evaluating instream flow requirements. Next year, as we solicit input from stakeholders, these models will be integral to evaluation of various water management options consistent with the study goal.

We continue to ask for citizen and stakeholder support in securing the funds and resources necessary to fulfill all of the original study objectives within our five-year timeframe.

Noel Osborn, Coordinator
Arbuckle-Simpson Hydrology Study

An Inside Look at Byrds Mill Spring

by Noel Osborn

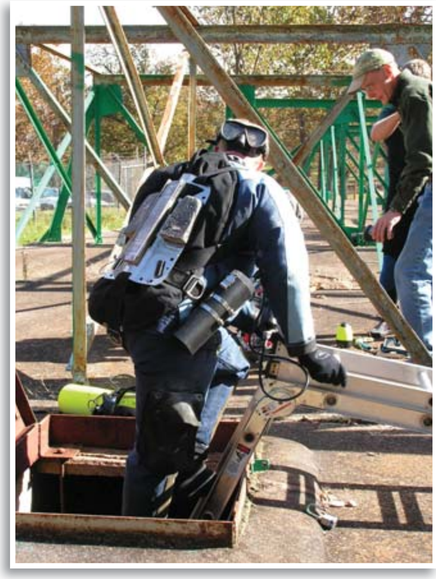
Situated between Blue River and the Town of Fittstown on the northeastern edge of the Arbuckle-Simpson aquifer, is perhaps the most well known spring in Oklahoma. With average annual flows of 19 cubic feet per second (cfs), Byrds Mill Spring is the largest spring in the state. The spring was named after Byrd's Mill, which was located about two miles downstream in what was once the town of Franks. The gristmill was built in 1870 for Benjamin Franklin Byrd, the brother of William L. Byrd, prominent Chickasaw Governor. Byrds Mill Spring has supplied water to the City of Ada since 1911.

If you visit Byrds Mill Spring today, you will not see a scenic bubbling oasis; rather, you will see water flowing from under a large cement structure topped with a metal truss. After purchasing the spring in 1910, Ada built a simple concrete wall around the spring as a barrier to animals. Then in 1927, the City contracted Jay Randolph Construction to build a cover over the spring. The structure, which required one year and $425,000 to complete, is anchored to the old wall. From a braced framework hangs a series of triangles and horizontal beams that are set in concrete. The dimension of the covered area is 103 x 60 ft. From the spring enclosure, water is diverted to a pipe, where it flows 12 miles downhill to Ada. The overflow spills over a weir to form the headwaters of (Byrds) Mill Creek.

Cement enclosure and metal truss covering Byrds Mill Spring

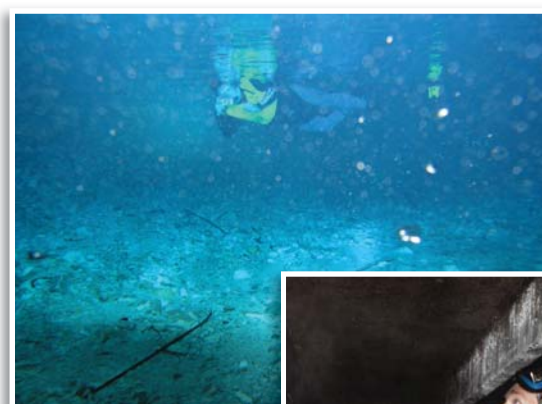
Few people have seen the actual spring since it was entombed 80 years ago. Although the spring is normally locked for security reasons, the City of Ada gave special permission to a small team of researchers to enter the spring enclosure to collect water samples for the Arbuckle-Simpson Hydrology Study. In November 2005, U.S. Geological Survey hydrologist Scott Christenson led the team into the enclosure to collect samples directly from the spring's source. Not knowing what conditions to expect, the team followed a USGS safety plan for confined spaces. Shannon Wallace, an experienced cave diver, entered first to survey the area and test the air.

Inside the spring enclosure is hidden a large pool of clear, bubbling water. The water does not flow into the spring enclosure from a cave or fissure. Rather, water flows from a shallow, gravel filled pool, similar to Buffalo Spring in the Chickasaw National Recreation Area. On the day of sampling, the pool was a few feet deep on the edges and deepened to about 8 feet in the center. According to USGS gage data, the spring was flowing at a rate of 13.5 cfs. The water temperature was a cool 65 degrees. Except for a small sliver of light coming in from the opening at the weir, it was very dark inside the enclosure. Bubbles effervesced from the sandy bottom like a giant glass of sparkling water. The spring actually fizzed.

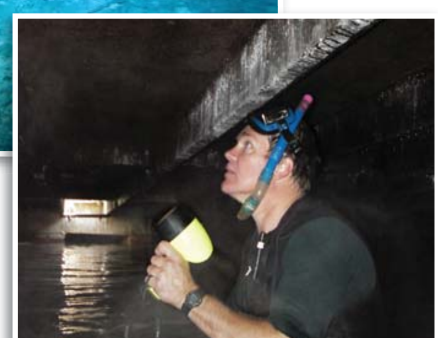


Cave diver Shannon Wallace entering the spring enclosure

The bubbles are composed primarily of nitrogen and carbon dioxide gas, which occur naturally in the aquifer. Atmospheric nitrogen contained in precipitation is entrained when water recharges the aquifer. Carbon dioxide comes from plant respiration and decomposition of organic matter. When groundwater discharges at the spring, changes in temperature and hydrostatic pressure cause degassing, and thus the bubbles.



Diver inspects the spring enclosure



Dr. Randall Ross (EPA) examining interior walls of the enclosure

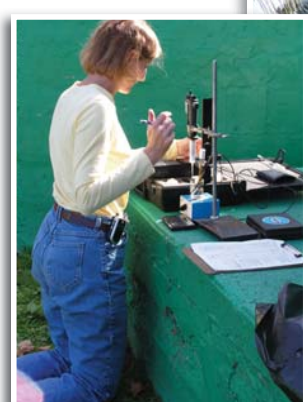
Christenson collected the water samples, which were analyzed for major cations (such as calcium, magnesium, and sodium) and anions (chloride, sulfate, and bicarbonate), trace metals (arsenic and iron are examples), nutrients (various forms of nitrogen and phosphorous), oxygen and hydrogen isotopes, noble gases (such as argon and helium), tritium (a radioactive form of hydrogen present in minute quantities), and carbon-14. As expected, the spring water is of very good quality, with a dissolved solids

Noel Osborn taking a close look at the spring

concentration of 322 milligrams per liter (mg/L). The water is a calcium magnesium bicarbonate type, which is characteristic of Arbuckle-Simpson waters near Byrds Mill Spring.

USGS geochemists David Parkhurst and Andrew Hunt determined, from noble gases and tritium data, that the age of the water is about 30 years, meaning that the water entered the aquifer about 30 years ago as infiltration from precipitation. Preliminary analyses of helium and carbon-14 data indicate there may also be

Dr. Elizabeth Bergey collecting fauna from the weir



Noel Osborn assisting with alkalinity titration

an older component of water. According to Christenson, it is not uncommon in large springs, where many flow paths converge, to have a mixture of old and young waters. Most probably, Byrds Mill Spring is mostly modern water with a small component of older water. Information gained from the water sampling will augment the geochemistry study of the aquifer and will provide insight into the aquifer's flow system.

In addition to sampling the water, organisms living in the spring were also examined. Dr. Elizabeth Bergey, with the Oklahoma Biological Survey, accompanied the sampling team to inventory spring fauna. The only aquatic invertebrates found in the spring enclosure were small crustaceans called isopods. Most were found in a beer bottle near the weir, and a few were observed scrambling in and out of the fine gravels in a shallow corner of the enclosure.

The research team from the Arbuckle-Simpson Hydrology Study wishes to thank the City of Ada for granting permission to enter the spring enclosure to collect water samples.

Ada's Conjunctive Water Use

Depending on the season, the City of Ada uses 4 to 8 million gallons of water per day. Following a drought period in the 1950s, Ada drilled three wells in the Arbuckle-Simpson aquifer to supplement water supply when spring flow was low. The wells are located 1 to 2 miles south of the spring and can pump up to 2,500 gallons per minute. During the dry years of the late 1970s and early 80s, the spring's flow began to decline and downstream landowners challenged Ada's water rights. Some landowners along Mill Creek initiated legal action against Ada and the OWRB, claiming Ada's use of water from Byrds Mill Spring interfered with their right to benefit from the natural flow of the creek by their property. The Oklahoma Supreme Court agreed. As a result, when flow in the creek is low, Ada withdraws groundwater from its wells instead of from the spring to preserve some spring flow for downstream landowners. During the 1980s and 90s, when spring flow was high, Ada pumped very little water from the aquifer; the average reported withdrawal from 1981 through 1999 was less than 100 acre-feet per year. Since that time, well withdrawals have increased. In 2006, when the region was experiencing a drought and spring flow was low, the City pumped 3,500 acre-ft from the aquifer.

Coming soon to the OWRB's Web site, a short underwater video of the sampling project.

More information on the history of the spring and surrounding area is available in "A Story of Byrds Mill Spring, Ada's Fountainhead," by Grace Boeger.

To join the Arbuckle-Simpson Study mailing list, call the
Oklahoma Water Resources Board
at 405-530-8800.

For more information on the study, or to view the Study's 2006 Annual Report visit the OWRB's Web site
www.owrb.ok.gov

Water Samples of Deep Test Well Indicate Fresh Water at 1,800 Feet

Ten months after drilling the Spears Test Well #2, the U.S. Geological Survey returned to complete the sampling. The 1800-foot well was not sampled during drilling due to concerns that the water samples would be contaminated with drilling fluid and air.

In July 2006, the USGS Central Region Research Drilling Project installed single and straddle inflatable packers in order to obtain depth-stratified samples. USGS hydrologists Scott Christenson and Carol Becker collected water samples from five discreet intervals for a comprehensive suite of analytes (major cations and anions, trace metals, nutrients, oxygen and hydrogen isotopes, noble gases, tritium, and carbon-14).

Chemical analyses of the water samples indicate that the water was fresh with uniform major-ion and trace-element chemistry from all depths. Major ion and trace element chemistry showed very little variation from the highest to lowest interval in the test hole. The dissolved solids concentration ranged from 322 to 332 mg/L, a difference of only 3 percent. None of the chemical analyses of the zones indicated elevated concentrations of sodium or chloride. These results demonstrate that fresh water, remarkably similar to shallow Arbuckle-Simpson water, is circulating at a depth of 1,800 feet.

Christenson hopes that the sample results will be used to construct a water chemistry profile with depth at this location. Age dating of deep groundwater can determine recharge rates of the lower regions of the aquifer, and it can better define the direction and velocity of groundwater flow. USGS scientists are analyzing water-quality data collected for the deep test well in addition to other data collected for the geochemical study. A USGS Scientific Investigations Report describing the geochemistry of the aquifer will be published soon.

Carol Becker, a hydrologist with the USGS, collecting water samples from the test well

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Oklahoma Water Resources Board
3800 N. Classen Boulevard
Oklahoma City, Oklahoma 73118

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