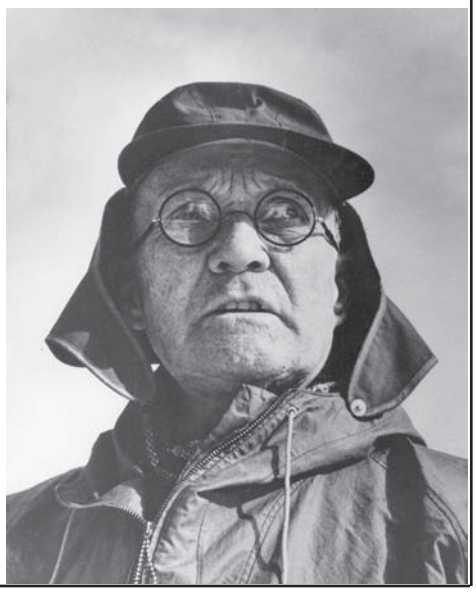
Donner Summit Historical Society
June, 2009 addendum
Newsletter

History of Central Sierra Snow Laboratory at Soda Springs, California

unabridged version. An abridged version appeared in our June, 2009 newsletter.

The Sierra Nevada snowpack is California's most valuable natural resource, and not because of the popularity of winter sports. When all that frozen precipitation melts it supplies more than half of the Golden State's total water supply. The first attempts to study this vital resource got underway right here in the Lake Tahoe-Donner Summit region.

The earliest studies of California's vital mountain snowpack began with Dr. James E. Church (right), a Michigan native who was hired in 1892 by the University of Nevada in Reno to teach Latin and Greek. Known as the Father of Snow Surveying, Church was ready to return home after he arrived in Reno and watched a man shot in a saloon gunfight die at his feet. Lucky for us he gazed up at Mount Rose, which towers impressively above the city, and decided to stay



Dr. Church is well known for his pioneering work in the science of snow surveying during the early 20th century. In 1905, he established the first Sierra weather observatory atop 10,776-foot-high Mt. Rose (southwest of Reno), and then later developed procedures for measuring the depth of snow and its water equivalent. Church learned that snow is an elastic substance and its depth does not indicate the amount of water in it.

Church's research investigating forest influences on mountain snowpacks led him to design the Mt. Rose Snow Sampler, a hollow metal tube that hydrologists thrust plumb into the snowpack to extract a core of snow. The sample core is then weighed on a specially calibrated, portable scale to determine its water content, a simple but effective system that is still used today.

Church made news in 1911 when he used his snow sampling system to predict the seasonal (spring) rise in Lake Tahoe's water level. Winter storms had dumped nearly 50 feet of snow on the Sierra and Church's data enabled

water managers to avoid damaging floods that spring.

For decades California and Nevada had fought over water rights on the Truckee River and its primary source Lake Tahoe. Early in the 20th century, the two states were in the midst of a bitter water war. By providing officials with streamflow forecasts to better manage storage in Lake Tahoe, Church's new forecasting tools subdued the conflict. Expanding the snow surveys outside the Tahoe Basin dramatically improved the accuracy of runoff predictions for the Truckee River, Reno's main water source.

Church made many important contributions to snow and water management and he is deservedly revered as the "Father of Snow Surveying". But Church didn't have the equipment or academic training to delve more deeply into the complex physical structure of the snowpack. A major advance for scientific research into the Sierra Nevada snowpack would come in 1945 when U.S. Weather Bureau physicist Dr. Robert W. Gerdel (right) was directed to build the Central Sierra Snow Research Laboratory at Soda Springs (near Donner Pass).

During World War II, government officials recognized the need to improve the management of the country's precious western water resources. For several years the Army Corps of Engineers had encountered problems determining spillway design for floods, and the Weather Bureau was having trouble meeting its responsibilities for streamflow forecasting.
In 1943, the Weather Bureau partnered with the University of Nevada to establish the Soda Springs Snow Research Project to learn more about the inner workings of the Sierra snowpack. Church had been studying snow in the region for years, but the Weather Bureau sent out Robert W. Gerdel, a physicist who had extensive technical training. Based in Sacramento, Gerdel was in charge of the technical aspects of the Soda Springs research project, with an emphasis on studying the hydro-dynamics of snowmelt and its relationship to runoff. Staff engineers were directed to use the information to help develop flood control structures.

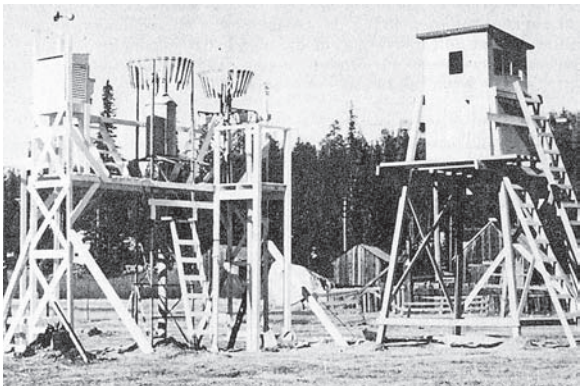
In 1945, the Army Corps of Engineers and the Weather Bureau joined forces to organize the Cooperative Snow Investigations Research Program (CSIRP), and Dr. Gerdel was appointed Technical Director. Gerdel had an aptitude for engineering as well as a strong drive for accuracy and professional competence.

As Technical Director of CSIRP, Gerdel was responsible for locating and building three federal snow laboratories. Key objectives were to solve design problems for multi-purpose reservoirs and improve runoff forecasting for energy and irrigation supplies, as well as flood control. Already familiar with the Donner Pass region, he chose Soda Springs to establish the Central Sierra Snow Laboratory. It's in a region that receives significant annual snowfall, but is also subject to heavy winter rain. The other two labs were located in Oregon and Montana.
The Snow Investigations Program wasn't organized until 1945, but due to his earlier work with the Soda Springs Snow Research Project, Gerdel had installed an instrument array behind the Soda Springs Hotel to study weather

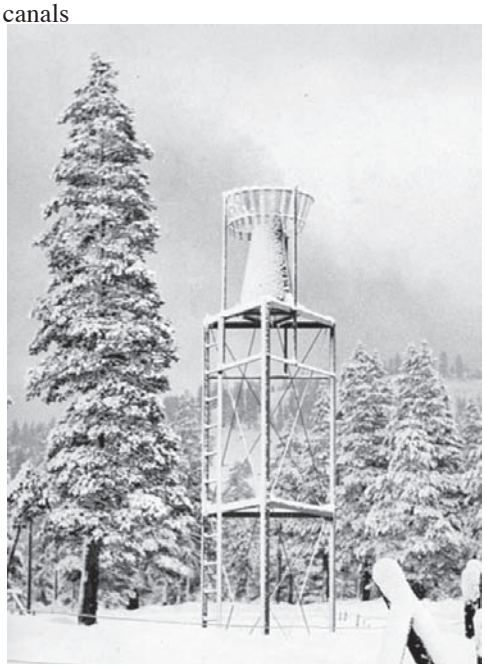
Top: Dr. James Edward Church, father of snow surveying, photo courtesy of hte Univ. of Nevada special collections.

Bottom: 1943 Soda Springs instrument platform.

and the mountain snowpack. During the winter of 1943-1944, resources were scarce due to the war effort and Gerdel and Church had to share an abandoned gasoline station next to the hotel as a base to conduct their research. These two men were very different in temperament and training, but both would spend most of their lives studying and reveling in the mysteries of snow and ice.



Conducting snow science at storm-wracked Donner Pass is a real challenge, but Dr. Gerdel had been overcoming adversity most of his life. Born in St. Louis, Missouri, on October 4, 1901, Robert Gerdel grew up in the snow country of Michigan's Upper Peninsula. When he was 12 years old a doctor had performed a successful tonsillectomy on the Gerdel family's kitchen table, but a bad infection permanently damaged his ear canals and left him deaf. When Gerdel entered high school the principal tried to have him committed to the Michigan School for the Deaf, but Gerdel successfully persuaded the administrator to give him a chance. He learned to lip-read and went on to earn masters and doctorate degrees in physics and chemistry from Ohio State University.



By late 1945 construction was well underway on the federal lab at Soda Springs. Once the two-story research building was completed, Gerdel supervised the installation of its state-of-the-art electronic equipment. Church was not part of the federal Snow Investigations Program, but he continued to operate out of his small facility behind the Soda Springs Hotel. He would spend many more years sharing his knowledge of snow science, but there was no doubt that the arrival of Gerdel and the establishment of the new snow lab represented a transition to more advanced research technologies. The scientists at the lab did use the Church-designed snow samplers to measure water content, but they also recorded solar radiation, the temperatures of air, snow and soil, wind velocities, and more.

The staff at the Soda Springs lab included a physicist (Gerdel), hydrologic engineer, meteorologist and an engineering aid. The hydrologic engineer in charge of the snow surveying courses was Ashton Codd, a University of Nevada graduate and longtime protégé of Dr. Church. The meteorologist Bill Enloe had previously spent three winters in Alaska and was well acquainted with mountain weather conditions. Parley Merrill was an experienced engineer who assisted each of his colleagues in their own special projects. All the men were good skiers, except Gerdel who preferred snowshoes. It was the dawn of a new era for snow science and mountain water management.

Nuclear Technology

Among the many achievements made at the lab, in 1948 Gerdel and B. Lyle Hansen developed the first nuclear snow gage, which used radioactive material to measure the water content of the snowpack. Hansen was director of the lab and a whiz at designing cutting-edge instruments like the radioisotope snow profiler. During the summer months, Gerdel and Hansen took a small capsule of radioactive Cobalt 60 to a remote location where the material was placed at ground level and a Geiger counter suspended by a cross arm 15 feet above. As the emitted gamma rays passed through the winter snowpack, collisions with water molecules lowered their energy

Pictures this page
Top: Soda Springs wx instruments. First instrument array at Soda Springs 1943.
Middle: WX gage designed by Dr. Gerdel 1943
bottom: 1944 Tucker two-pontoon runabout used by Dr. Church parked at the Soda Springs gas station. J.M. Tucker is the man in the middle.

level which indicated the amount of water in the snow. The Geiger counters were rigged with radio-transmitters so that their measurements could be relayed in real-time to the snow lab, but with the idea that ultimately off-site hydrologists in Sacramento or San Francisco could also receive the signals.

This radio-transmitted system was the first step in establishing an array of remote sensors in the Sierra snowpack, an important breakthrough in snow surveying. Until this point, measurements of the snowpack relied on teams of men to ski or snowshoe into the mountains where weather and avalanches were a significant hazard. In addition, the stomping around to position the snow sampler often disturbed the snow, which increased the chances of error. At the time, Gerdel said, "The radioisotope procedure is expected to make possible the maintenance of a good, continuous inventory of snow more completely and over a much large area than has been possible before."

The idea of using nuclear material to remotely measure snowpack density was brilliant and scientists have substantially improved the technology. The modern radioactive isotope profiler has the photon source and detector mounted on a pair of parallel vertical tubes topped by a lift mechanism that moves them up and down synchronously through the snowpack. The gage's principal value lies in its ability to repeatedly measure the same vertical section of snow and thus provide a window into rapid changes in the snowpack such as the rain-on-snow events that sometimes lead to flooding.
Dr. Gerdel was Technical Supervisor at the Central Sierra Snow Lab from 1945 until 1950, at which time he was reassigned to a new government agency known as SIPRE, the Snow, Ice and Permafrost Research Establishment.

Snow Pillows & SNOTEL
In the decades since Gerdel's team developed the first snow gage that could relay real time measurements via radio waves, scientists have come up with more durable, accurate and sophisticated instruments. But modern hydrologists still use the low-tech Mt. Rose Snow Samplers devised by Church a century ago. Five times each winter teams of surveyors use simple hollow aluminum tubes to extract and weigh core samples in order to determine how much water to expect during the spring runoff. Modern technology has improved the hydrologist's arsenal, but the human surveyors will probably always play an important role.

During the 1960s, the development of automatic sensors for obtaining snowpack water content from remote areas grew rapidly. Pressure pillows (snow pillows) were installed at various locations in the Sierra. Snow pillows are large vinyl bladders filled with a mixture of alcohol and water that are placed on the ground and protected from wild animals by wire mesh. The snow pressure pillow is basically a hydraulic weighing platform that determines water content by recording the weight of the snowpack that accumulates over the bladder.
In the mid 1970s, scientists incorporated meteor burst telemetry technology to relay information from the snow pillows that were usually located at inaccessible, high elevation sites. It's an ingenious system that relays radio signals long distances by bouncing them off the ionized gas trails of meteor dust in the upper atmosphere. This technique allows real-time data

top: first snow survey tractor 1945

middle M-7 tractor pulling skiers. Dr. Gerdel is being pulled and is the left most. 1945

bottom: 1946 Dinnertime at the snow lab. Left to right: Dr. Gerdel, Parley Merrill, Bill Enloe, and Ashton Cod.

transmission between a remote sensor site and a collection station up to 1200 miles away. Currently, data are transmitted by meteor burst to a master station in Boise, Idaho, or Ogden, Utah, and then automatically forwarded to a central computer in Portland, Oregon.


SECOND FRONT PAGE

The Sacramento Unic

SACRAMENTO, CALIFORNIA, SUNDAY MORNING, MARCH 24, 1946

Four Men Start Seven-Year Vigil Probing Secrets Of Sierra Snows, Hoping to Develop Flood Controls

By DON K. WHITE

CENTRAL SIERRA SNOW RESEARCH LABORATORY, ON CASTLE CREEK NEAR SODA SPRINGS—Plotting the course of a single drop of water from the time it trickles off a snowbank 7000 feet in the Sierra Nevada until it flows under the Tower Bridge in Sacramento ... that, and a little more, is the purpose of this laboratory.

The four men at the laboratory, working under a co-operative agreement between the Army Engineers and the U. S. Weather Bureau, are not preoccupied with the single drop of water, naturally, but rather with the entire runoff of the basin.

Castle Creek is a headwater tributary of the South Fork of the Yuba River. This 4.5 square mile basin is reasonably typical of the various headwater basins of the Sierra Nevada streams in shape, geology and forest cover. Three Other Reasons

Other reasons for choosing this site for the laboratory operations were:

1—It is located on the western slope of the mountains and has a deep and persistent snow cover.

2—It is subject to heavy rainfall during major winter storms.

3—The entire runoff can be measured at one point, and the lower end of the basin is accessible throughout the winter months.

Flood producing runoff in the

FOUR MEN AT THE LABORATORY pause at 8000-foot level. Much of their work is done on skis or snowshoes. They are Dr. Robert W. Gerdel (left), Ashton Codd, Parley Merrill and Bill Enloe. Snow at this level is nine feet now.

west should be considered as a vast reservoir just as truly as man-made dams. The sun's heat

show how much solar heat is being absorbed by the snow.

Another instruments records wind velocity and direction, and the duration of sunshine at one minute intervals. Then there is the microbarograph, which records changes in barometric pressure.

The instrument that records the actual runoff of the water is the portable water level recorder, which is connected to the still pool behind a flume constructed on Castle Creek, 100 yards from the laboratory.

The water flows through the flume and over a rectangular weir. Knowing the size of the weir and the depth of the water in the still pool they can determine the exact amount of water flowing through.

Don't get the idea, however, that the men sit comfortably in their oil-heated laboratory and jot down readings from the recorders.

There are frequent trips to the six snow courses that have been laid out in the area. These courses are a series of spots where snow samples are taken. Long tubes are inserted through the snowpack and then pulled out, filled with snow. Long slits running the length of the tube show the quality and type of the snow.

The tube is then put on a portable scale and weighed to determine the water content.

It might be well to explain

men stationed at the laboratory would have preferred to have a scientific name for snow. All of their equipment has multisyllable names, they use terms in their work whose titles hurled daily at the uninitiated—and at this point and circumstance, cavemen, and Ruhe Goldberg contrivances are trying to solve the riddle of a thing whose name is often on the lips of infants—

Sacramentan Heads Party

Dr. Robert W. Gerdel is head of the snow research project for the Engineers and Weather Bureau. He has been in snow research or allied fields for 22 years.

Dr. Gerdel received his doctorate in physics from Ohio State University in 1926. His wife, Mrs. Grace Gerdel, who holds a doctorate in botany, and his 20-year-old son live at 2433 42nd Street, Sacramento.

The staff at the laboratory includes a physicist, hydrologic engineer, meteorologist and engineering aide. Gerdel is the physicist.

The hydrologic engineer is Warren R. Codd, a graduate of the University of Nevada and a protege of Dr. J. E. Church who is known as the "snogineer of these research work in the west. Church is a retired professor of the classics at University of Nevada who now making snow work a full-time sideline.

Ten Years in Alaska

Codd and Dr. Church started

FLUME AND STAGE RE... basin. Water flows throu... pool, exac...

...miles down the road from ... at Kingvale, where he stays ... his wife and 3-year-old son, ...ley Merrill IV, who, for bre... sake, is called Duffy.

All of the men are good s... with Codd, perhaps, being ... most expert. Until a few ... ago they did most of their ... work on skies or snows... which necessitated long, ar... trips over tough terrain.

This survey system called SNOTEL (for SNOwpack TELemetry) revolutionized data collection by giving hydrologists daily measurements from a network of more than 600 SNOWTEL sites throughout the West. The remote stations rely on solar power and batteries, and the system can accommodate a variety of other sensors, including wind speed, wind direction, relative humidity, solar radiation, water level, soil moisture, soil temperature and others.

Gamma Ray Detectors

In the 1990s, the Central Sierra Snow Lab began retiring its mechanical snow pillows, which sometimes work erratically and occasionally get disturbed by curious bears, replacing them with more accurate gamma-ray detectors that were developed at Sandia National Laboratories in Livermore, California. It's a high-tech, but straightforward technology where sensors are designed to detect these rays, which bombard the Earth constantly as a product of the cosmic energy of deep space. It works because water absorbs gamma radiation at the same rate whether it is in its liquid or frozen phase. Sensors are placed on the ground so that as snow piles up during the winter months, it can determine the SWE of the snowpack by the difference in voltage between the sensor under the snow and a sensor mounted on a tower above the snowpack. Because cosmic radiation is relatively constant, after a period of time the sensor mounted on the tower can be removed and the one under the snow compared to the established standard.

top: newspaper headline

bottom: staff on skis 1946. From left: Dr. Gerdel, Ashton Codd, Parle Merrill, Bill Enloe

Satellite Technology

The latest tool being utilized to improve snowpack and snowmelt runoff forecasts incorporates satellite technology. Even since the 1940s, government agencies have employed visual surveys and aerial photographs from low flying airplanes to estimate flood threats and improve reservoir management. The contribution of satellite sensing is still limited at this time, but can be particularly helpful when all the ground-based snow telemetry sites have melted out

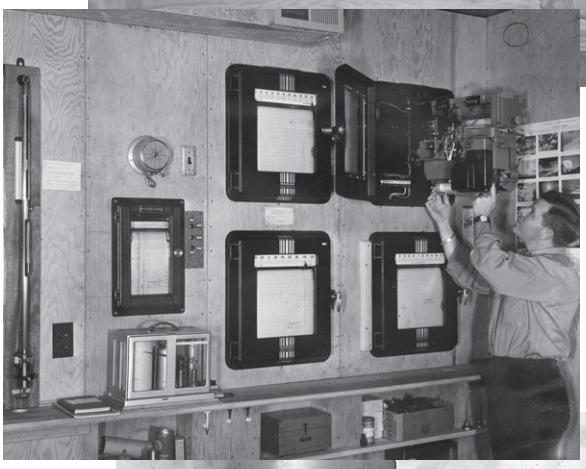
and an estimate of the remaining snowpack at the highest elevations is needed. The use of satellites to augment snow surveys and telemetry stations is more limited in the western U.S. The best results from remote sensing by satellites occur in flat open terrain with clear skies and minimal vegetation, while western U.S. landscapes are timbered, rugged and complex. In the future, satellites will likely play a contributing role in runoff forecasts, but at this time using this technology is expensive and still in the experimental stages.

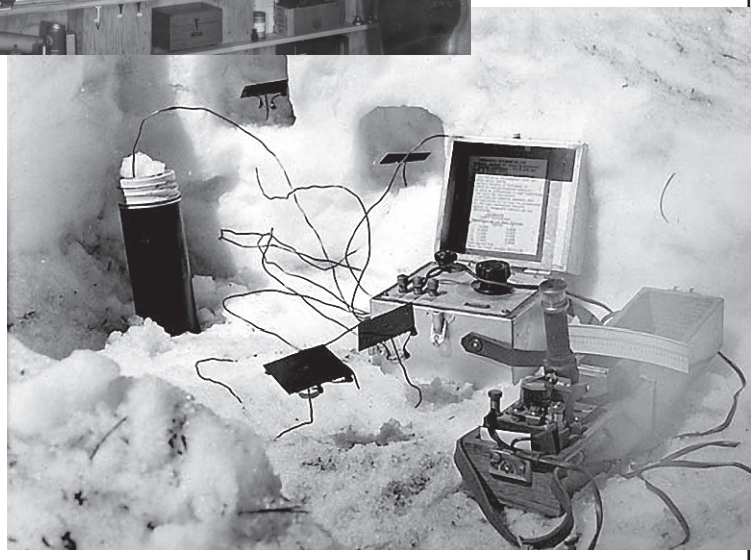
As technology improves, automated sensors provide accurate data more frequently than can a snow survey team, and at less cost. But hydrologists acknowledge that the manual snow course measurements made by people probably won't be replaced anytime soon.

Impact of Snow Lab Science

The winter snow surveys provide crucial information for successfully managing California's extensive reservoir and irrigations systems. In addition to providing reliable conditions for studying the physics of a deep snowpack, research conducted at the Central Sierra Snow Lab was critically important to developing flood control projects and the effective management of California's water supplies. Over the years, water users and voters have invested more than $50 billion (in 2007 dollars) for a coordinated statewide water system.

The research performed at the Soda Springs lab has enabled hydrologists to closely monitor snowfall and snow melt, information that helped establish California's State Water Project and the federal Central Valley Project. Together, these large-scale water transfer projects provide Sacramento River Delta water to 25 million Californians and irrigate millions of acres of farmland. They also directly support more than $400 billion of California's economy.





Some of the best and brightest have cut their teeth at the Central Sierra Snow Lab. Scientists like Jim Bergman, who ran the lab for 23 years and left in 1989 to become a forest hydrologist for the Tahoe National Forest. Other top-flight, snow lab alumni are Rick Kattelmann, Dave Azuma, Neil Berg, and Bruce McGurk, all of whom have contributed much to our understanding snowpack hydrology.

Alive & Kicking

top: 1946 water stage recorder. Ashton Todd was a protege of Dr. Church.

bottom: 1946 instrument panel as the CSSL. Recorders register snow, air temperature, incident and refracted radiation. Bill Enloe is in picture

Bottom: coaxial thermocouple pyrheliometer. Used to measure the depth to which solar radiation penetrates snowpack. 1947

In the late 1990s, budget cuts forced the Forest Service to close down the lab, but fortunately the University of California came to the rescue. Today (2009) the Central Sierra Snow Lab is managed by Randall Osterhuber who took charge after Bergman's departure. The University of California, Berkeley operates the lab under an agreement with the U.S. Dept. of Agriculture, the Forest Service's Pacific Southwest Research Station, and in cooperation with the California Dept. of Water Resources. To learn more or to schedule a visit to the lab, contact Randall Osterhuber at: http://research.chance.berkeley.edu/cssl/

Pioneering efforts by Dr. Church, Dr. Gerdel, and others to investigate and improve our scientific understanding of the complexities of the vital Sierra snowpack have laid the groundwork for an extensive snowpack and water management system that has helped nourish and sustain California's growth into an economic giant. The threat of climate change and its inherent challenges to the state's extensive water system make this work more important than ever.

Tahoe weather historian Mark McLaughlin is a nationally published, award-winning author and photographer. He can be reached at mark@thestormking.com

heat from the sun; the wind velocity and direc-

Atomic Byproduct Will Check On Hidden Sierra Snows

By WARREN HOLLOWAY

By the use of a byproduct of the atomic bomb, a group of government employes expect soon to solve the mysteries of snow melt and stream flow in inaccessible areas of the high Sierra Nevada.

Their work is of vital importance to the success of the Central Valleys Project.

A knowledge of how much water will come from the Winter's snow, and from where and when it will come will make possible the maximum use of some $1,000,000,000 worth of water and power development in the central valleys.

Under the supervision of Dr. R. W. Gerdel, a research physicist for the United States Weather Bureau, the men intend to accomplish this by using radioisotopes in an area north of the Donner Summit.

The radioisotope looks like ordinary powdered aluminum contained in a pill bottle, but it really is powdered zinc which has been bombarded in the atomic pile at Oak Ridge, Tenn.

sity vary with the snow melt and water content.

The pulses also can be recorded on a meter or transmitted by radio.

Accredited By AEC

Dr. Gerdel has been accredited by the Atomic Energy Commission to engage in this special research. He has spent years studying the many and complicated related theories. Officially his title is technical supervisor of the Cooperative Snow Investigation. The work is operated jointly by the weather bureau and the army corps of engineers and conducted in three snow laboratories.

They are
Laboratory at
County; the
Laboratory
Park, Mont.,
Basin Laborat
east of Albany
B. Lyle Ha
physicist, is
laboratory a
sponsible for
special instru

top: 1946 March snow survey 6 feet deep. Ashton Codd and Parley Merrill

center right: Mt. Rose snow sampler in action circa 1950's

bottom: Soda Springs Hotel 1951

top: first nuclear snowgage first designed by Dr. Dgedel and B. Lyle Hansen

Bottom right: Gerdel Church exhibit at the Tahoe City museum

bottom left: Ashton Cod waxing skis.

top: plowing Old 40, January 1952 during the blockade.

Below: Randall Ostehuber, current manager doing a snowpack study 2004

Below left: snow pillows 2008

Bottom: Randall Osterhuber and the snow pillows 2008