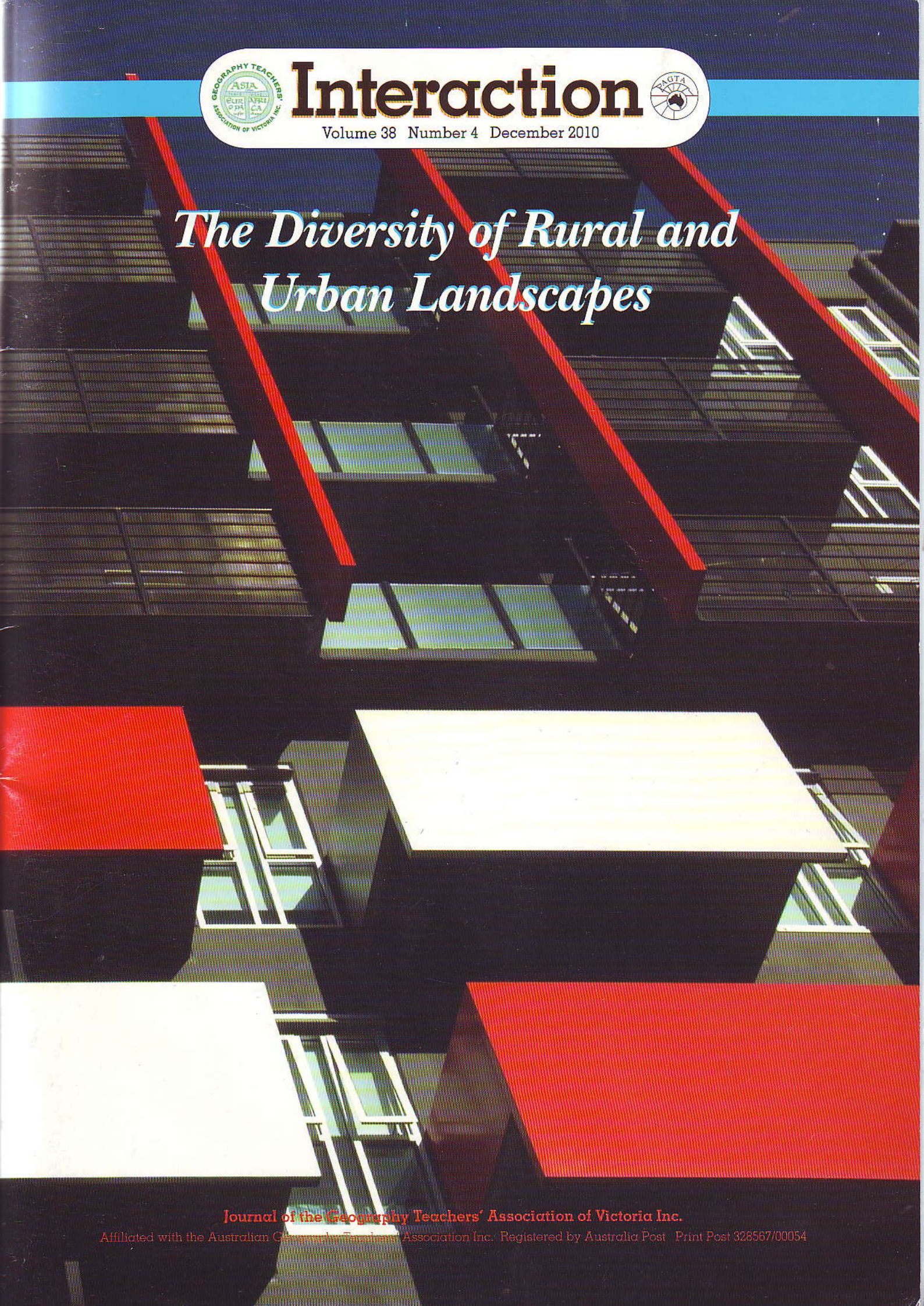
Interaction
Volume 38 Number 4 December 2010

The Diversity of Rural and Urban Landscapes



Journal of the Geography Teachers' Association of Victoria Inc.
Affiliated with the Australian Geography Teachers' Association Inc. Registered by Australia Post Print Post 328567/00054

Geothermal systems and geology

Charles Davidson, Peninsula Hot Springs

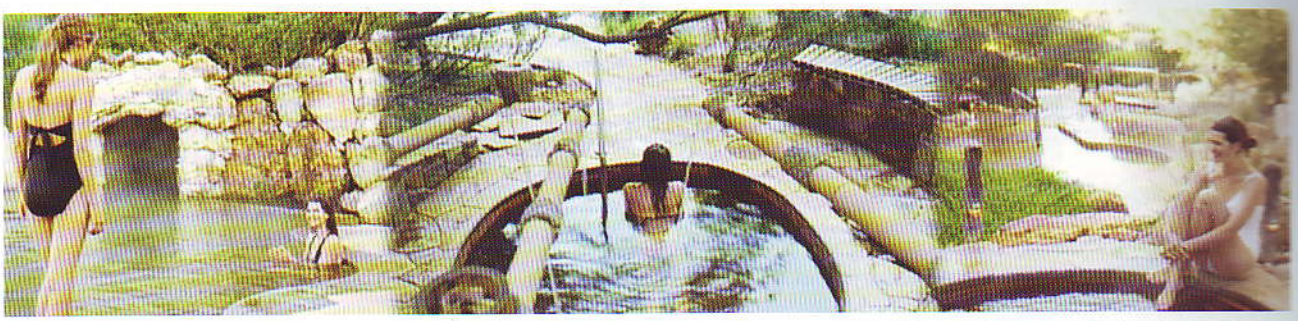


Figure 1: *Visitors at Peninsula Hot Springs*

Living geology

Learning programs have been established at Victoria's only natural mineral spring and spa centre located 1.5 hours south of Melbourne on the Mornington Peninsula. The natural thermal mineral water at the heart of the learning program originally fell as rain in northern Australia many thousands of years ago. It now bubbles up at 47°C through the Selwyn Fault on the Mornington Peninsula from 637 metres underground.

Students gain an understanding of Geology and Geography through the combination of a fieldtrip to Cape Schank, classroom discussion and experiencing the hot springs bathing. The paper presented at the GTAV Annual Conference provided an introduction to elements of learning provided in the program.

Background

Peninsula Hot Springs is a natural hot mineral spring and spa centre. Waters heated to 47°C flow through a bore from an aquifer 637 metres below the surface. The hot springs waters are used for bathing and the heating of buildings.

The inspiration for Peninsula Hot Springs came from a visit to a hot springs town in Japan in 1992. The lovely relaxation experience of bathing in the mineral waters, surrounded by nature, inspired the search for hot springs in Australia. Five years later, in 1997, one of the company directors learnt that a test drilling program by the Victorian State Government had discovered that there was hot water at over 500 metres depth on the Mornington Peninsula. He then joined with his brother to purchase the 17 hectares of land on which the hot springs are situated. To gather development ideas, many trips were made to hot springs across the world including China, Russia, Yemen, Egypt, Nepal, United States and New Zealand. Some of the ideas helped develop the cave pool, cold plunge pools, reflexology walk and the deeper exercise pool.

Why is the water hot?

The centre of the earth is over 6000° Celsius and full of molten rock (liquid hot rock). The deeper towards the Earth's crust, the higher the temperature rises. On average, temperatures rise 4°C for every 100 metres of depth. Due to the Selwyn Fault Line, which runs through the Peninsula from Mt Martha past Arthurs Seat and onto Cape Schank, the temperatures are higher than usual. The seismic movement of the fault line generates heat and also encourages the flow of deeper heat from within the earth. The combination of the elevated heat of the earth and the presence of water make it possible for the springs to exist. Water acts as an exchange medium, much like a battery for electrical energy, bringing the heat from the earth to hot spring pools for us to enjoy.

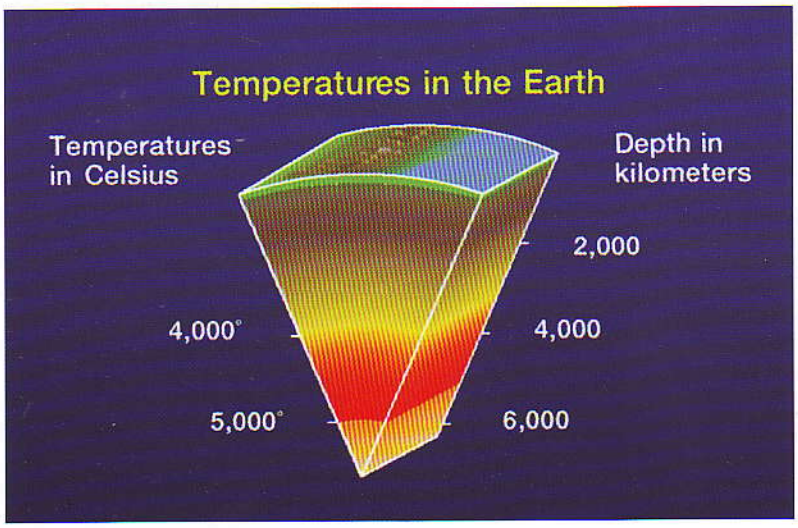


Figure 2: *The Earth's temperature increases towards the centre*

Where does the water come from?

Peninsula Hot Springs water initially fell as rain in Northern Victoria. The rain seeped into the Earth through faults and fractures. As it moved underground, it was subjected to increased energy from natural geothermal heat, and was exposed to gases and a wide variety of minerals from rock and mineral deposits. The water adsorbs minerals via leaching, is heated by the geothermal heat source (the Earth), and then returns to the Earth's surface via the bore. It is estimated that the water is at least 10 000 years old, and possibly much older.

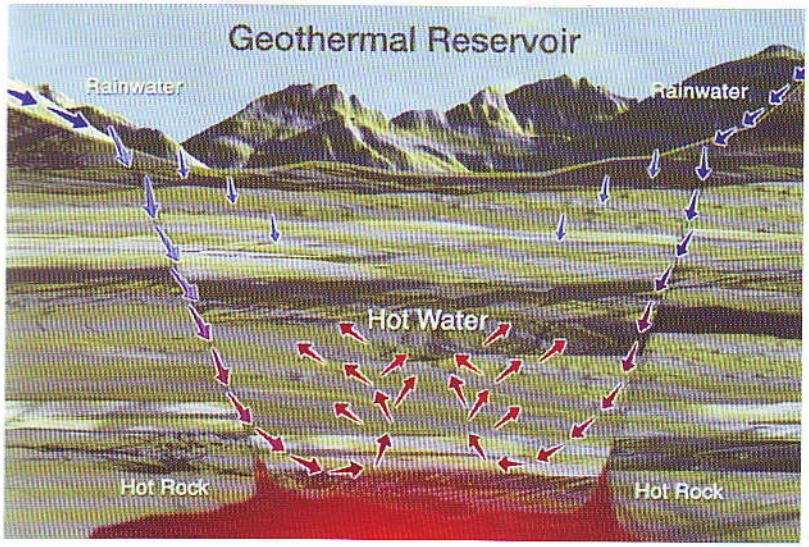


Figure 3: *Hot water rises to the surface via faults and fractures*

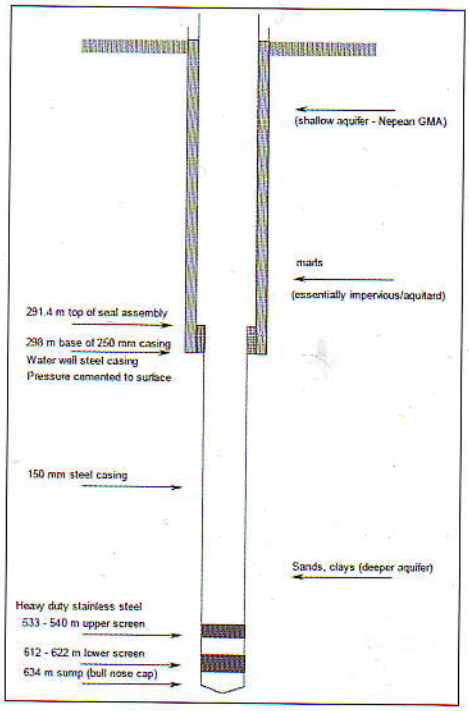


Figure 4: *A bore with a pump brings hot water to the surface at Peninsula Hot Springs*

How the water gets into the hot spring pools

The natural hot water flows up the bore from over 600 metres depth to within nine metres of the surface under its own pressure. From there, a pump located in the bore moves the hot water through pipes to the pools. Every pool has its own inlet that supplies fresh hot mineral water directly from the bore.

The temperature of pools, much like a domestic bath, varies depending on the speed at which the tap is turned on and whether additional cold mineral water is added. Cold ground water is available on the Peninsula Hot Springs site enabling the regulation of temperatures to the pools.

Drilling

In order to access the natural hot water, a bore was drilled down to where the heat and the water can be found. A first attempt was made to drill a bore in 1998, however it failed due to human error. A second attempt commenced in 2006 and, despite being advised that it would take three months for completion, it took 18 months, finishing in early 2002.

Once the initial bore was dug, and before the bore was cased, a machine was sent down the bore to analyse the various geological layers to determine where flowing water could be found. To extract water from a bore it is necessary to find sandy layers in which screens (casing with holes in it) can be placed to enable the water to flow into the bore.

Such sandy layers were found at a depth of 530 metres and also 612 metres. The completion of the bore in 2002 enabled the building of the hot springs pools to commence. Peninsula Hot Springs first opened in June 2005.

Geothermal energy – a sustainable resource

Geothermal energy is classified as a renewable resource as the energy removed from the resource is continuously replaced by the heat of the earth. Provided the flow of water continues, the supply of the heat energy will continue.

To assure the continual flow of water, Peninsula Hot Springs limits the volume of extraction to a level that does not cause the water level in the aquifer to fall. A second bore has also been drilled that will be used to re-inject water, after filtration, into the aquifer thus retaining the long term water levels. In addition to using the hot water in the pools, the buildings at Peninsula Hot Springs have pipes running under the floors with heat from the hot springs water flowing through them. This form of heating is known as hydronic heating and reduces the need to use other forms of non-renewable heat energy such as electricity, oil or gas.

Lab. Ref. no. 2301511 Clients Field ID: Peninsula Hot Springs					
Bicarbonate	(total)	mg/L 1163			
pH		6.82			
Analysis temperature	°C	19			
HCO3/Date	Analysed	14/08/2003			
Aluminium	mg/L	<0.02	Manganese	mg/L	0.08
Ammonia (asNH3)	mg/L	2.7	Mercury	mg/L	<0.0005
Antimony	mg/L	<0.001	Molybdenum	mg/L	<0.001
Arsenic	mg/L	<0.005	Nickel	mg/L	<0.003
Boron	mg/L	1.3	Nitrate (as N)	mg/L	0.03
Bromide	mg/L	3.6	Lead	mg/L	<0.0005
Calcium	mg/L	116	Phosphate (as P)	mg/L	<0.05
Cadmium	mg/L	<0.0003	Potassium	mg/L	64
Cesium	mg/L	<0.02	Rubidium	mg/L	<0.14
Chloride	mg/L	1432	Silica (as SiO2)	mg/L	23
Cobalt	mg/L	<0.001	Sodium	mg/L	868
Copper	mg/L	<0.003	Strontium	mg/L	1.7
Chromium	mg/L	<0.003	Sulphate	mg/L	2.7
Fluoride	mg/L	0.73	Sulphide (as H2S)	mg/L	0.86
Iron	mg/L	<0.1	Tin	mg/L	<0.003
Lithium	mg/L	0.15	Vanadium	mg/L	<0.005
Magnesium	mg/L	90	Zinc	mg/L	<0.038
Conductivity	µS/cm	5540	Ion balance		-2.5

Figure 5: *Analytical Report: Peninsula Hot Springs – Victoria, Australia*

Mineral content of the water

The primary minerals in Peninsula Hot Springs' water are sodium, chloride and bicarbonate as well as significant levels of magnesium, potassium, sulfur, boron, selenium and many trace minerals. There is a total mineral content of 3700 parts per million of dissolved minerals in the Hot Springs water.

What the mineral water does for you

The two primary areas of benefit derive from the minerals in the water and the temperature of the water. Waters with a temperature of over 42°C are considered hot springs and those with a total dissolved mineral content of 1000 mg/l or more are considered mineral springs. Peninsula Hot Springs rises to the surface at 47 °C with a total mineral content of 3700 mg/l.

European balneologists have extensively studied the therapeutic value of mineral waters. Mineral springs with different mineral contents are often recommended above others for various therapeutic uses. In addition to the value of the trace minerals found in most hot springs, and the stimulating benefits of highly mineralised waters, balneotherapists generally agree on the following observations:

- bathing in bicarbonate water assists the opening of peripheral blood vessels and helps to improve circulation to the body's extremities
- at cooler temperatures (30–37° C) these waters can be used for hypertension and mild atherosclerosis
- mineral springs that are naturally rich in sodium and chlorides are considered by some researchers to be beneficial for rheumatic conditions, arthritis, central nervous system conditions, post-traumatic and postoperative disorders, as well as orthopedic and gynecological disease
- magnesium converts blood sugar to energy and promotes healthy skin; potassium assists in the normalisation of heart rhythms, in reducing high blood pressure, helps to eliminate body toxins and promotes healthy skin
- mineral adsorption via hot springs soaking is extremely small; and the amount adsorbed into the body is concentration dependent and varies depending on the mineral and its chemical form. Even so, medical balneotherapists have noted that even minute amounts of therapeutic minerals adsorbed into the body via the skin have a significant therapeutic value.

Email: charles@peninsulahotsprings.com
Web: www.peninsulahotsprings.com