that, although thick sediment can block water flow, it may still allow exchange of chemicals between the crust and bottom water by means of diffusion. Russell McDuff and Joris Gieskes of Scripps Institution of Oceanography have studied variations with depth in the concentrations of magnesium and calcium in pore waters. These variations, which appear in about one-half of DSDP cores, suggest that calcium is diffusing up from the crust, and that magnesium is diffusing down from the bottom water.

Although the evidence from coring indicates that only low temperature processes have affected the crust, rocks dredged from the sea floor often show the effects of seawater alteration at high temperatures. These rocks, termed greenschists, contain a group of minerals quite unlike the minerals found in crustal cores and are typical of temperatures in the range of 200° to 250°C. These rocks were probably brought to the sea floor from some depth by the large-scale vertical faulting of the crust.

A recent study by Susan Humphris, now at Lamont-Doherty, and Geoffrey Thompson, at Woods Hole, of greenschist samples dredged from the Mid-Atlantic Ridge shows that the chemical changes accompanying the formation of greenschists could be important in global chemical cycles. Significant changes had occurred in the contents of magnesium, calcium, some transition metals, and silica. The chemistry of these alteration products was in reasonable agreement with that deduced for basalts exposed to hot seawater in the laboratory by James Bischoff of the U.S. Geological Survey at Menlo Park and Frank Dickson of Stanford University. But the significance of these changes for the composition of seawater had always been a matter of considerable debate because no one could tell how much of the crust was actually affected by hot seawater.

Warm Spring Chemistry

The discovery last year of hot, mineral-enriched seawater springs on the crest of the Galápagos Ridge has allowed the first estimation of the importance of high temperature crustal alterations to the overall composition of seawater. The discovery followed a sophisticated search for a phenomenon that some believed must exist but no one expected to be as striking as it turned out to be.

After following a trail of subtle clues to a spot 340 kilometers north of the Galápagos Islands, a team of researchers assembled by John Corliss of Oregon State University descended 2800 meters in Woods Hole's submersible *Alvin* into the dark, 2°C waters over the Galápagos Ridge. They were hoping to locate and sample wisps of slightly warmer water, which they expected to be only a degree or so warmer than bottom seawater, as the water rose from the very center of the ridge. Instead, they found plumes of shimmering, sometimes cloudy, warm water pouring from among the bottom rocks. The maximum temperature recorded was 17°C. Even more surprising were the dense colonies of crabs, fish, foot-long clams, giant tube worms, and other exotic animals thriving in the noxious spring waters at ocean depths where normally only an occasional worm scratches out an existence. These animals compose a unique ecosystem that, by feeding on sulfur-loving bacteria, ultimately derives its energy from the geothermal sources beneath the ridge. The

Speaking of Science

Killer Bees: O Death, Where Is Thy Sting?

The popular image of "killer bees" has them attacking humans—and killing them—in a manner reminiscent of the birds in the Alfred Hitchcock movie. Perhaps not surprisingly, many observers, including officials of the United States Department of Agriculture, think that this picture has been overdrawn. Although no one disputes the nasty disposition of the creatures, their main threat appears to be more to the economic health of the beekeeping industry in affected areas than to the public health. In fact, officials of the USDA and scientists studying the problem wince at the name "killer bees," which they think is a misnomer, the result of sensationalized reporting. As Marshall Levin of the USDA put it: "I feel the same way about the term 'killer bees' as the president of General Motors would feel about the term 'killer cars.' "

The preferred name is "Africanized bees," which reflects the origin of the strain. In 1956, a Brazilian geneticist brought a race of African bees (*Apis mellifera adansonii*) to Brazil with the idea of breeding them with the local bees in order to obtain a more productive honey bee for South America. The Brazilian bees, which were derived from European honey bees, were not very vigorous and were relatively poor honey producers in the tropics whereas the African bees were supposed to be industrious workers that made a lot of honey in tropical conditions.

Unfortunately, a few months after their importation, 26 swarms of the African bees with their queens escaped from the apiary where they were being studied. And the hardy, aggressive nature of the bees suddenly became a problem as they began to outcompete, outbreed, and ultimately displace the Brazilian bees in many areas. In the last 21 years the Africanized bees have migrated rapidly in all directions from their point of release.

Africanized bees are more easily disturbed and provoked to attack than are European bees. Despite this—and despite the deadly reputation Africanized bees have acquired—Orley Taylor of the University of Kansas, who has been studying the natural history of the bees for the past 4 years, says that he hears of fewer than a dozen attacks, only some of which are fatal, each year in all the areas of South America that are now inhabited by the bees. (For comparison, at least 40 persons, usually individuals who are allergic to bee venom, die of bee stings annually in the United States.) Although there is no system for reporting such attacks and there could be more that do not come to Taylor's attention, he points out that a phenomenon this hard to track down could not be very widespread.

If the impact of Africanized bees on public health has been slight, their impact on beekeepers has been severe. Taylor says 50 to 60 percent of the beekeepers whose colonies are taken over by Africanized bees quit the job because the invaders are harder to manage than the European bees they are replacing. Beekeepers may need special equipment for handling Africanized bees, such as protective clothing, which is a nuisance in hot climates. They also need to establish their colonies at least 200 meters away from human habitation and domestic animals to minimize the risk of the bees being provoked to attack.

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color films from these dives still draw large crowds of viewers, but now the chemical analyses of the water samples are equally alluring to geochemists.

The compositions of the collected hydrothermal waters, being determined principally by John Edmond and his colleagues at the Massachusetts Institute of Technology, show that very high temperature reactions are occurring between seawater and the crust. The amount of silica leached from the rocks into the hydrothermal water indicates that the seawater was heated to 300°C at some point, but it does not boil because of the high pressure at the sea floor. Experiments by Bischoff and Dickson show that the high temperature can generate the observed high acidity, as low as *p*H 3 in the reaction zone, by precipitating magnesium from seawater as sulfates and silicates. Oxygen is also consumed, probably by reaction with iron, producing reducing conditions.

Corliss and Edmond believe that the seawater in cracks perhaps 2 kilometers below the surface is heated by conduction from a magma chamber immediately below the depth of seawater penetration. The hot seawater rises toward the surface, drawing in fresh cold seawater to be heated. Before the hot water can reach the surface, it is diluted by cold water that has percolated into the system at shallower depths. Dilution has no chemical effect on many of the leached elements, such as lithium and calcium. The changes accompanying dilution (decrease in temperature, increase in oxygen content, and increase in *p*H) do affect a number of elements. For example, copper, nickel, and cadmium are totally removed—even the very small amounts present in the initial seawater. They are apparently precipitated as sulfides onto the walls of the cracks. This precipitation process is thought to be responsible for some major mineral deposits, such as those mined for copper on Cyprus. Small veins of copper and zinc sulfide have actually been found in dredge samples.

The behavior of these trace metals, and that of iron and manganese, during dilution in the Galápagos warm springs helps explain the origin of the metal-rich deposits commonly found along ridge crests. In the Pacific, the deposits are sediments highly enriched in iron and manganese with smaller amounts of trace metals. Previous studies have shown that the trace metals are derived from seawater itself, not crustal rocks. A seawater origin can be explained by the removal of leached metals as sulfides and the adsorption of metals from seawater by the iron and manganese as they precipitate and settle into the sediment. In the Atlantic, metal-rich sediments are less common, and manganese is often deposited as extremely pure manganese dioxide coatings on bottom rocks. Edmond suggests that greater dilution of hydrothermal waters, a likely situation in the more fractured Atlantic crust, causes the complete removal of the iron within the crust, leaving the manganese to be deposited alone.

A fortunate circumstance of warm spring chemistry allows some estimation of the importance of hydrothermal discharges in the chemistry of the ocean even though only one spot on the 64,000-kilometer ridge system has been sampled. Along with the other elements leached from the rock, an isotope of heli-

(Continued on page 1187)

Another problem for beekeepers is that Africanized bees do not want to stay put in the hive. A colony of Africanized bees may produce as many as 8 swarms per year compared to the one or two produced by a European bee colony. Swarming occurs when a queen, together with her workers and drones, leaves the parent colony to establish a new colony. This divides the population and honey production goes down until the populations go up again. Swarming occurs when conditions are good. When conditions are bad bees tend to abscond entirely as they leave the hive to search for greener pastures. Africanized bees are highly prone to absconding.

In any event, beekeepers eventually can accommodate to the African bees. According to a report from the U.S. National Academy of Sciences, honey production at first decreased but then increased in the areas of southern Brazil where the bees have been established for the longest time. Moreover, bees in these areas apparently have less aggressive characteristics than those in northern Brazil where the African bee takeover is more recent. Presumably, beekeepers in the South have been selecting the gentler strains for breeding.

When Africanized bees swarm or abscond, they often travel long distances, up to an estimated 50 miles before establishing a new home. The fact that the bees have been found on islands 10 to 12 miles from the coast of French Guyana indicates that they can fly at least that far on a single flight.

These flying feats have enabled the Africanized bees to travel great distances since their release. The southward migration has currently ceased in Argentina, but they are still moving northward and have now been spotted in Caracas, Venezuela. They may eventually—perhaps in 10 years—reach the United States, although this is not certain.

Taylor points out that there are many wild bees in Mexico whereas there were few in South America before the Africanized bees moved in. Lack of a vigorous population of indigenous wild bee competitors has been a major factor in the expansion of the Africanized bees throughout South America. Whether they will be able to outcompete and displace the bees of Mexico as readily as they have displaced those of South America is not clear. If they began to breed with and acquire some of the characteristics of the Mexican bees they might also become less aggressive.

Moreover, colder climates may help to block the northward spread of Africanized bees. There are indications from the distribution of the bees in South America that they cannot tolerate the cold as well as European bees. Lack of cold tolerance may have stopped the southward migration in Argentina. Of course, Africanized bees might pick up cold tolerance by breeding with European strains, but this has apparently not yet happened, a fact suggesting that the two strains are not completely compatible genetically.

The USDA Bee Breeding and Stock Center Laboratory in Baton Rouge is exploring ways to moderate the aggressive tendencies of the bees by genetic means should they arrive in this country still as feisty as they are in South America. One promising line of research involves the identification of the pheromones (chemical communicators) that may be responsible for evoking their aggressive behavior. Thomas Rinderer of the Baton Rouge laboratory says that it may be possible to select strains that either produce less of the pheromones or respond poorly to them. Such strains should be gentler and less prone than the Africanized bees to take aggressive defensive action when they are disturbed. The gentle strains might then be used by beekeepers and commercial bee suppliers to breed out the aggressive traits of the immigrant bees.—J.L.M.