around 20 to 22 cents and from oil and gas it is closer to 30 cents."

Ultimately, the final answer regarding utilization of the potential steam fields is a matter of economics. After the present exploration phase is over—probably by fall—and the potential sites for steam fields all mapped out, economists will have to sit down and figure out if the area can be exploited economically.

The main question is whether the water obtained from the wells would be economically competitive with the water from northern California, Oregon and Washington. At present, the cost of geothermally desalinated water is much greater than Colorado River water, but as the Southwest area grows and its water needs increase, the potential fields will become economically competitive with the sources of northern rivers that would otherwise have to be called upon. Since the steam fields offer a source of water close at hand, the transportation costs involved in bringing water down from the Columbia River, for example, would work in favor of the fields.

The steam in the fields could last from 100 to several hundred years and could even operate long after that if the depleted underground water is replenished by outside sources. Since the heat would still be there, bringing in massive quantities of seawater would perpetuate the operation of the steam fields.

Another reason for introducing seawater is to prevent ground subsidence. Dr. Rex envisions dredging a channel 150 miles inland to Yuma, Ariz., for this purpose. Indications are that a subsurface grid network exists near Yuma that could act as the site for injection of the seawater to spread it to the rest of the Imperial Valley, thus replenishing the used underground water. This channel would make Yuma an inland seaport benefiting both the southwestern United States and the northern desert area of Mexico.

In addition to water and power, the geothermal brine offers possibilities as a source of minerals, calcium chloride, potassium chloride and bromine. There is no need for its salt since land sources are more than adequate. Present in the brine are small amounts of lead, rubidium and strontium, but their extraction with present technology would be economically unfeasible.

The high geothermal energy of the valley comes from hot plastic material circulated in the earth's crust and underlying mantle like a huge subterranean convection cell, with its axis extending into the Pacific Ocean. The Imperial Valley is located above the upward moving portion of this convection cell.

SOYUZ

Space lab progress

Soviet space planners, like their U.S. counterparts, have long been interested in the potential of manned, earth-orbiting space stations. It was not until the last year or two, however, as the Apollo program began to pick up speed, that reports from Russia began to indicate that space stations were apparently eclipsing even a moon landing in priority.

The inference is that once Soviet officials found the country's moon program severely trailing that of the U.S., they turned to a task upon which they could more readily capitalize. There could be an additional rationale, however: Although both lunar and earth-orbiting programs promise great scientific gains, the cost—and applied usefulness—of mounting a sustained orbital program is substantially less than that of keeping up a sustained effort on the moon.

Technologically, there are two basic approaches to creating a space station in orbit. The National Aeronautics and Space Administration, in its Apollo Applications Program, plans to launch the main body of the station as one huge unit, contained within the third stage of a Saturn 5 rocket, then follow that with devices such as a large telescope mount which will be attached externally later. Crews of from 6 to 12 men will be ferried up and down in modified Apollo spacecraft.

The Soviet Union, on the other hand, favors sending up the station a segment at a time, in the form of individual spacecraft which would couple in orbit to form a large structure.

In the Soviet system, sections presumably could be either guided automatically or flown by cosmonauts. Russia first demonstrated the automatic technique almost a year and a half ago, on Oct. 30, 1967, when Cosmos 186 and 188 met and docked in space, spent the better part of a day together, then descended and landed separately. Last May the feat was repeated with Cosmos 212 and 213.

Then last month, four cosmonauts proved out the manned part of the plan. On Jan. 14, Vladimir Shatalov flew the Soyuz 4 spacecraft into orbit, followed a day later by Soyuz 5, carrying Cosmonauts Boris Volynov, Yevgeni Khrunov and Alexei Yeliseyev. After the two spacecraft maneuvered to within about 110 yards of each other, in an orbit varying between 130 and 156 miles above the earth, Shatalov flew his spacecraft across the remaining distance and coupled it to Soyuz 5. The final approach took about 45 minutes.

Once the spacecraft were locked together, Yeliseyev and Khrunov moved from their spacecraft's command module into its work compartment, depressurized it and opened the hatch. They then clambered outside, leaving Volynov at the controls, and spent about an hour working their way along handrails toward the work compartment of Soyuz 4, where they entered and joined Shatalov. Both craft landed safely.

UPI/Novosti

Shatalov docks Soyuz 4 and 5.

The first U.S. transfer of astronauts from one spacecraft to another is planned for the upcoming Apollo 9 mission, to be launched Feb. 28. James McDivitt and Russell Schweickart will first make an internal transfer, crawling through a hatch from the Apollo command module to the lunar module: then Schweickart will step out into space, move down to the command module and back again to the LM, though, unlike the Soviet feat, he will not open the other vehicle's hatch.

If Russia does plan to assemble increasing numbers of spacecraft into large stations, this may well require some sort of central module, probably launched unmanned, that can hold several spacecraft all at once. The Apollo Applications space station will have one, mounted at one end of the main structure, designed to let as many as five separate spacecraft and scientific payloads lock together around a central hub like spokes in a wheel.

NASA is also considering another system that is a combination of the two approaches. At its Langley Research Center in Virginia, it is now working the bugs out of a design in which a space station would be assembled in orbit from individual building blocks—a crew compartment, laboratory unit and power station, for example—but the sections would be launched as many as three at a time by a single booster. ◇