

OF BURROW-WORLDS



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1. Introduction

While reading *The Last Space Viking* in the summer of 2011, I was struck by a line on page 16. “On too many planets the natives no longer bothered to improve anything, or just retreated into the jungles or other inaccessible places—providing thin gruel for Space Viking raiders.”¹

“Other inaccessible places” made me think, what about underground or under water? In *Four-Day Planet*, H. Beam Piper mentions burrow-cities, and in *Space Viking*, he mentions under water dome cities. The only example of a burrow-city that he names is Port Sandor on Fenris, but Beam never included an underwater dome city in a story—though its mention in *Space Viking* may have been a deliberate foreshadowing for a future tale.

It occurred to me, however, that back when the Space Viking raids became widespread in the Old Federation—or even earlier, when the Terran Federation first broke up and the Interstellar Wars began—a few civilized planets may have realized they were on the verge of reverting to barbarism. They had few options. They could resolve to go down fighting, like the Kheperans in *Space Viking*, or they could attempt to leave, emigrating off-planet like the System States Alliance refugees centuries earlier.² But the latter option includes no guarantee they wouldn’t be detected and destroyed by enemy ships, or that they’d be able to find a suitable world before their supplies ran out.

If they don’t want to fight and they can’t run, the only other option would be for them to retreat—*into their planet*. Underground or under water. Most likely, their first choice for doing so would be to dig in, to move underground. A parallel of the ‘survivalist’ mentality. This paper therefore examines the nature of these postulated ‘burrow-worlds’; a small subset of “the half-thousand human-populated planets of the Terran Federation”.³

2. Burrow-Worlds

a) *Burrow-Cities*

An entire civilized planet retreating underground would greatly expand on Piper’s burrow-city concept, previously seen only on islands, moons and war-threatened nations. As stated in *Four-Day Planet*, “The Chartered Fenris Company shipped in huge quantities of mining and earth-moving equipment—that put the company in the red more than anything else—and they began making burrow-cities, like the ones built in the Northern Hemisphere of Terra during the Third and Fourth World Wars, or like the cities on Luna and Mercury Twilight Zone and Titan...”⁴

One of these burrow-cities is Port Sandor, built on “Oakleaf Island”, where the entire population of Fenris currently resides. Walter Boyd describes it to Glenn Murell. “You saw what [the city] looked like when you were coming down...Just a flat plateau, with a few shaft-head domes here and there, and the landing pit of the spaceport. Well, originally it was a valley, between two low hills. The city was built in the valley, level by level, and then the tops of the hills were dug off and bulldozed down on top of it.”⁵ Walt later adds that the burrow-city of Port Sandor is covered by what sounds like a dome. “The city roof curves down all along the south side of the city into the water and about fifty feet below it. That way, even in the post-sunset and post-dawn storms, ships can come in submerged around the outer breakwater and under the roof, and we don’t get any wind or heavy seas along the docks.”⁶ That appears to mean the city was built along the southern shore of Oakleaf Island, and the two low hills it was built between were to the east and west, also along the coast. After the city levels were constructed, the whole thing was covered by a dome, and then the dome covered with earth.

However, since the city roof extends into the water, bulldozing these hills should still leave part of the dome exposed, which seems to contradict Walt’s words about what Port Sandor looks like from above. An arc of the dome should be visible, along the coast just inside the breakwater. Unless the city was built at the tip of a small estuary or bay; in that case, only a small segment of the dome would extend below the water, placing the southern end of the city roof close to the entrance of the bay.

I don’t believe that Beam states what Port Sandor’s dome is made of; I always envisioned a thick layer of steel, but it could be reinforced concrete, or even a thin layer of collapsium.

The old burrow-cities in the Northern Hemisphere of Terra were certainly built by the Eastern and Western nations, to try and preserve their civilizations from nuclear attack, which would come from the

sky—bombs and missiles from the air and space. In a parallel fashion, enemy attacks during the Interstellar Wars, and later Space Viking raids, would also come from the sky and involve nuclear weapons. Assaults like these could potentially destroy a planetary civilization, which in turn could prompt the citizens of a few Old Federation planets to move underground.

Though primarily intended to save their civilizations, such a move would additionally make it much more difficult for future invaders to get at them, much less take anything of value. Sure, the attackers could drop a planetbuster or a hellburner, but that would destroy what they are trying to steal. Which is probably what happened on Terra; the goal of East and West was not plunder, but the destruction of the enemy.⁷ This resulted in the nuking of the burrow-cities, probably by Bethe-cycle bombs. These would ensure complete destruction, as seen on Seshat, in *Space Viking*. When Andray Dunnan drops two hellburners on that planet, “the cities on which they had fallen were still-smoking pits literally burned into the ground and the bedrock below, at the center of five hundred mile radii of slag and lava and scorched earth and burned forests.”⁸ A five hundred mile radius; *that’s a thousand-mile diameter!* Think of it; drop one hellburner each on Las Vegas, St. Louis and Baltimore, and the whole US would be nearly wiped out! No wonder the result on Terra was “the end of civilization in the Northern Hemisphere.”⁹

The North Terran burrow-cities could have been built under existing cities, such as New York and Moscow. In the normal hectic conditions of a major metropolis, such a massive construction effort would obviously be extremely difficult. But both New York and Moscow are nuked in WWIII, so the burrowing could have been an extension of the cleanup effort. The cities above ground have been devastated, so clear the surface and rebuild them underground, for greater protection against future attack. Or, clear the surface, excavate and build the burrow-city as a wartime refuge, then rebuild the surface city for peacetime habitation. In this way, some Northern cities hit by atomic bombs in WWIII could actually survive until being completely destroyed by hellburners in WWIV.

On the other hand, it would undoubtedly be easier to dig burrow-cities under smaller urban centers, or even better, brand new locations, at some distance from the major cities. This is what happened on Fenris, where originally “there were several cities built, over on the mainland... They’re all abandoned now. The first one was a conventional city, the buildings all on the surface. After one day-and-night cycle, they found that it was uninhabitable. It was left unfinished. Then they started digging in.”¹⁰



Figure 1. Possible burrow-city of the First Century AE; the multileveled Everytown, circa 2036.¹¹

b) Defense and Survival

After the fall of the Federation, the culture of these postulated 'burrow-worlds' would be defensive in nature, so they probably lose hyperdrive, and possibly give up on space travel entirely, if the Interstellar Wars and Space Viking raids are severe enough. But they could still retain atomic power and collapsium shielding, and would live largely on carniculture and hydroponics, like the people of Fenris. As Walter Boyd also says, "I went on telling [Murell] about our hydroponic farms, and the carniculture plant where any kind of animal tissue we wanted was grown—Terran pork and beef and poultry, Freyan *zhoumy* meat, Zarathustran veldbeest..."¹²

In *Space Viking*, however, Lucas Trask points out that "men tired of carniculture meat, and fresh meat was always in demand."¹³ So the burrow-worlds probably employ a *combination* of synthetics and real food. When they move underground, some of their people would certainly remain on the surface; growing crops, raising food animals, and procuring raw materials, such as mining and lumbering. All these activities could be guarded by a system of planetary detection stations or even orbital sentinels, like the *Sky-Spy* in *Uller Uprising*, but facing outward.¹⁴ These stations would be linked to missile launching sites. If an incoming Interstellar or Space Viking ship were detected, the warning should enable everyone to retreat into "underground attack shelters", like those on Poictesme.¹⁵ At most, the enemy's haul would consist merely of some crops and livestock, and maybe raw materials not yet secured below ground. Chicken-stealing; hardly worth the trip.

If the invaders express their displeasure at these meager pickings by dropping a few thermonuclears, the burrow-world's civilization will survive. Planetary losses will include some of the detection stations and missile launching sites, could cause some of the planet's croplands to become radioactive, and perhaps include the destruction of a burrow-city or two, with a well-placed planetbuster or hellburner. After suffering a few punitive nukes, the natives of a burrow-world would rebuild the destroyed cities and reclaim the croplands, though the latter might take decades if not centuries.

Even in a worst-case scenario—the entire surface becomes uninhabitable—the natives can still live almost indefinitely off their carniculture and hydroponics, like the people of Fenris. They would certainly get tired of it, and could therefore supplement the synthetics with sea-based food sources, assuming the oceans haven't been too contaminated.

But in fact, the farming areas of burrow-worlds would probably have their own shelters, which would include large underground barns for livestock and silos for grain. Indeed, the underground grain silos could be built to much the same design as the underground missile silos at the launching sites. And having such facilities would mean that a lot of these resources could be secured underground before the raiders arrive on the planet, to be returned to the surface if and when the all-clear is given.

The oft-cited example of Fenris raises the possibility that Fenris itself could be considered the first burrow-world.¹⁶ From an original high of 250,000 residents "at the end of the Fourth Century A.E.", the bankruptcy of the Fenris Company "ten years" later results in the swift plummet to a single thousand, but less than a century after that the number has rebounded to 24,708.¹⁷ If the trend continues for the next seven centuries of the Federation, then increasing population on Fenris will cause the other burrow-cities to be reoccupied, and possibly new ones built. So that by the end of the Terran Federation, the people of Fenris, who "are very tough, and we brag about it",¹⁸ may become a very respectable underground civilization, well-situated to survive the Interstellar Wars.

c) Tunnel-Masters

Though perhaps not on Fenris, where transportation by submarine may remain the norm, the people of most burrow-worlds would undoubtedly become quite proficient at tunneling. If your fear of space attack is so acute as to move all your cities underground, you would probably move at least some of your transportation routes there, too. As Klem Zareff says, "Staff brass don't like to get caught out in the rain, not when it's raining hellburners and planetbusters."¹⁹ Under that extreme sort of precipitation, a more secure way of moving things around would be advisable, rather than relying on the dubious chances of surface or air transport.

On the planet Poictesme, there are vitrified stone tunnels into Force Command Duplicate and Barathrum Spaceport. These are only "half a mile" and "two miles long".²⁰ Piper does not specify how the vitrified tunnels are created, but he mentions a road-laying vitrifier in Litchfield. "There was a big

vitrifier on the Mall—even at five hundred feet he could feel the heat of it—chuffing and clanking and pouring lavalike molten rock for a new pavement.”²¹ So the tunnels into Force Command and Barathrum could have been bored by nuclear-powered tunneling machines, that heat the rock and then push it aside, resulting in a smooth, strong (and presumably watertight) tunnel surface. If so, that would be superior to our current methods, in which the cold stone is slowly ground away, necessitating the placement and securing of concrete slabs to hold the surrounding rock in place and create the tunnel surface. A tunneling vitrifier would seem to be more efficient, more economical, and would probably accomplish the job much more quickly.

Vitrified tunnels would then be another concept that the postulated burrow-worlds greatly expand on. Underground highways and/or railways could eventually run for hundreds or even thousands of miles between burrow-cities. The inhabitants may also bore tunnels to the underground storage shelters for surface resources. If the air in these tunnels is evacuated, leaving a vacuum, vehicles could travel at great speeds, due to the lack of air resistance. Traveling in a vacuum would require the tunnels to have airlocks at either end, and the vehicles to be airtight. But vacuum is vacuum; traveling in an evacuated tunnel would essentially be the same as traveling in the vacuum of space. And since space travel in Piper’s universe is commonplace, a passenger vacuum train would theoretically be just as safe.

Whether the air is evacuated or not, another advantage to tunneling is that it shortens the distance between burrow-cities, since they can be bored straight through the crust, rather than following the curvature of the planet, as surface and air transportation routes have to do. Solid rock isn’t always solid, though; the various densities of strata would have to be taken into account, as would subsurface anomalies like fissures, caverns, and fault lines. So some of the shorter tunnels could be perfectly straight, while longer ones might have curved sections taking them around, above or below these obstacles.

Particularly interesting anomalies, on the other hand, would be deliberately bored close to. Scientists would certainly relish the ability, never before available, to investigate fault lines deep underground. And previously-unknown caverns with interesting rock formations or other naturally-occurring beauty could become subterranean tourist destinations.

d) Subterranean Trains

The underground transportation system could employ monorails, to minimize friction losses, as well as keep the trains on course at high speed. One example of a high-speed monorail from Piper’s later years was the Gyronaut. *“Inspired by President [Lyndon] Johnson’s call for a 200-mile per hour train for inter-city use, former automobile designer [Alex J.] Tremulis sketched this monorail design. [Figure 2.] The 200-seat vehicle would be stabilized by a gyroscope and bank like an aircraft, facilitating smooth and safe high-speed operation.”*²²

One can easily envision a Gyronaut-like monorail traveling through a burrow-world’s vacuum tunnel rather than on the surface. However, though a single large vehicle would work for high volume or long distance routes, it might not be cost-effective to run a 200-seat train if at times you only have 100 or even 50 passengers. So a Gyronaut may not be the best design for shorter tunnels, or those with smaller average traffic volumes. For these routes, multiple cars as in a conventional train would provide greater flexibility for the varying passenger loads of daily travel.

Monorails were ‘futuristic’ in Piper’s time, but in his Future History, contragravity is developed before the end of the First Century, in AE 92 (2034 AD). Thus, after the fall of the Terran Federation at least one burrow-world could take the next step, and equip the underground trains with contragravity generators. In that case they wouldn’t need rails at all, which would make them even more efficient. However, this would necessitate some method of keeping what is effectively a ‘flying’ train from colliding with the tunnel. Perhaps the contragravity generators can be linked to a proximity detector, such as radar, to keep the train’s center of mass at the center of the tunnel. Or maybe the tunnel surface can be lined with magnetic strips that repel the floating metallic train; a ‘magnetic repulsion’ system, the reverse of current magnetic levitation technology. Another possibility would be to coat the tunnel surface with an exotic material that actually repels the contragravity field, perhaps even distorting its shape and thereby forcing it to act as a ‘cushion’ between the train and tunnel.

I don’t recall Piper specifying the shape of a contragravity field, but would guess that it is spherical, like the hyperspatial fields of his spherical starships. So one option would be to have a ‘generator’ car at the

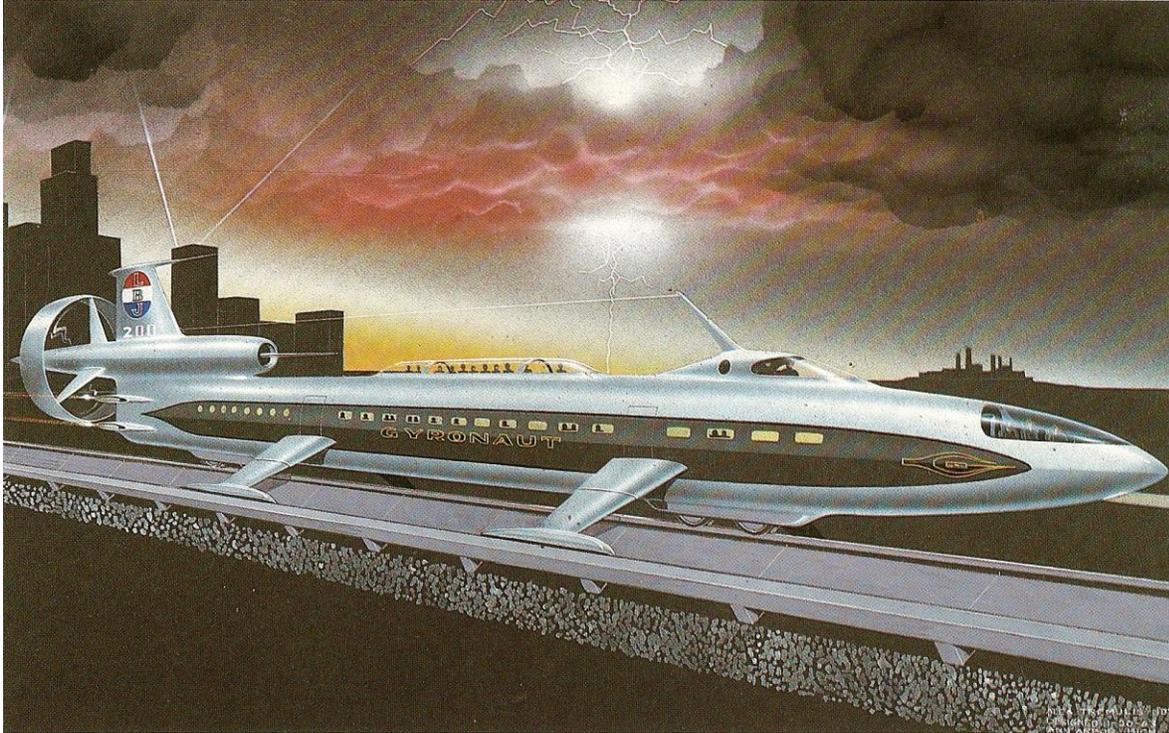


Figure 2. The Gyronaut, a high-speed monorail concept from 1963. ²³

center of each train, providing contragravity for all the cars at the same time. However, that would mean the generator would have to be very large and powerful, since I presume the field's diameter has to be wider than the train is long, in order to lift the whole thing. And that would be inefficient, since most of the field's energy would be enclosing empty space; or, possibly worse, solid rock. (Figure 3.) ²⁴ This would hold true if the tunnel is coated to force the field to distort its shape; the shape would be most distorted around the center of the train, and the compacted field in that area would be much more powerful than it needs to be.

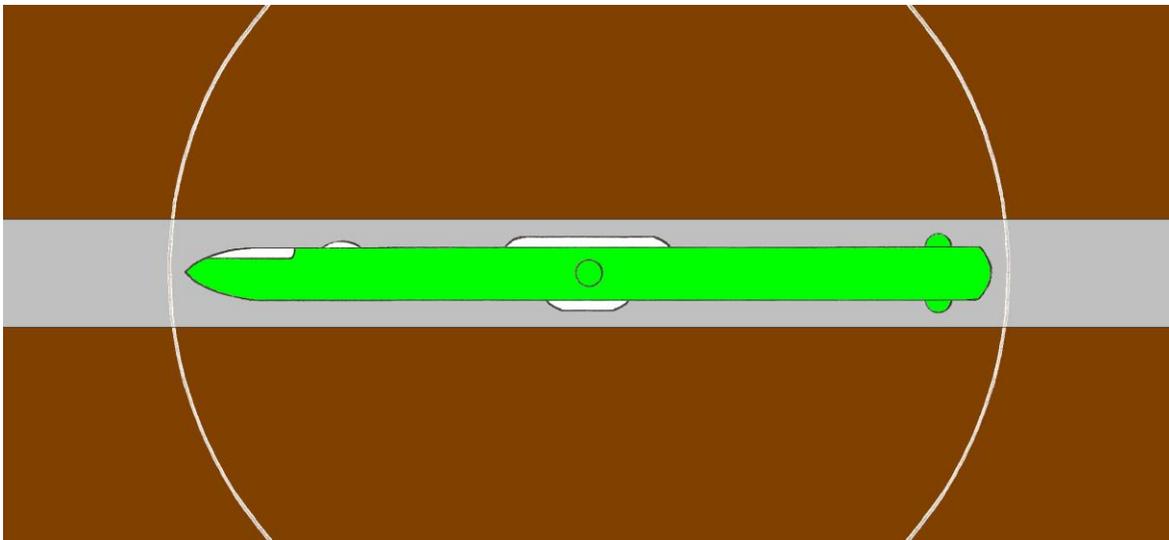


Figure 3. A modified Gyronaut; single vehicle contragravity train with single generator.

Fortunately, in Piper's universe small devices like air-cavalry single-mounts, individual robots, and even ornamental globes have their own contragravity generators.²⁵ Thus, each car in the train could have its own generator, meaning they can be designed to be smaller and less powerful, since each one only has to lift a single car. So the train would now be a line of cars, levitated by a series of interlocked contragravity spheres. (Figure 4.) Each sphere would hold much less wasted space, and would therefore be much more efficient. And if the fields are distorted to fit the shape of the tunnel, the difference in strength between the compacted part of each sphere (around the center of each car, this time) will be much less than in the single large contragravity field.

These single-car contragravity generators would of course be controlled from the engine, and linked to insure they function in unison.

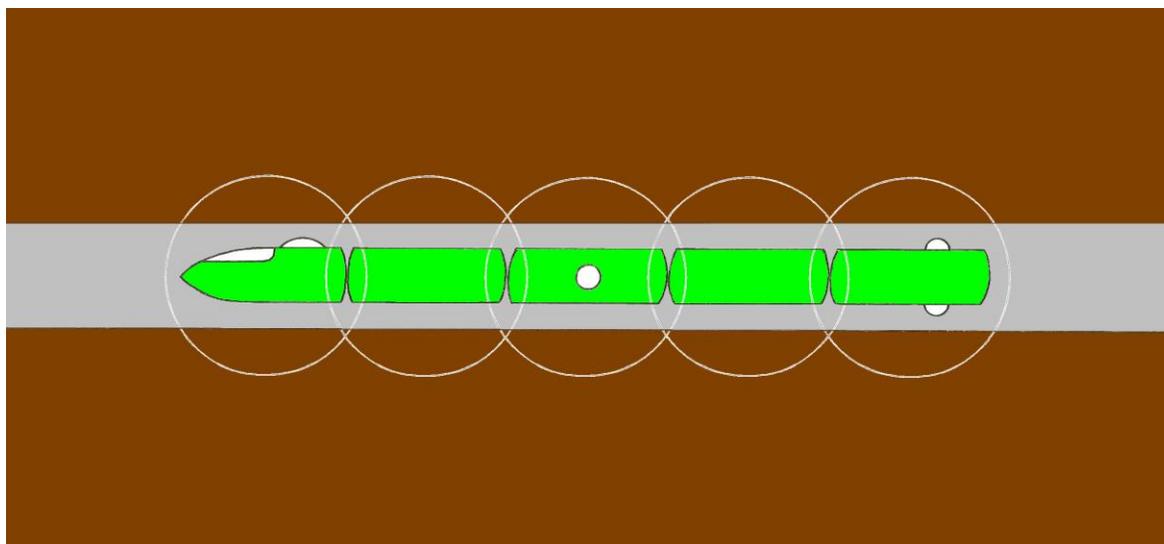


Figure 4. Multiple-car contragravity train design with multiple generators.

Another reason a flying train is possible in Piper's universe is because in *Four-Day Planet* and *The Cosmic Computer*, he has flying submarines. In the former book, the planet Fenris contains monster-hunting ships which can float, submerge, and fly. "A moment later [the *Javelin*] was on full contragravity, and the ship which had been a submarine was now an aircraft."²⁶ While in the latter novel, the planet Poictesme possesses air liners like the *Harriet Barne*. "Built to operate only inside planetary atmosphere and gravitation, the *Harriet Barne* was long and narrow, like an old ocean ship; more than anything else, she had originally resembled a huge submarine."²⁷

Moreover, a flying train could actually go other places—such as a planetary satellite, like the projectile-train depicted in Jules Verne's work *From the Earth to the Moon*. (Figure 5.) Indeed, somebody would certainly invent one sometime, because there will always be Terro-Humans who create things simply because they can. An airborne example from our time is Yves Rossy, the Swiss 'Jet Man'. In 2006, he invented a strap-on fixed wing, turning himself into the first jet-powered human.²⁸ Another such invention closer to Piper's time, and one that he might have particularly appreciated, was by Dave Robertson, a hydraulics engineer with Lockheed, who "in his spare time built toy square shells for a toy square cannon he invented, just to prove it could work."²⁹

One can therefore speculate that in the days of the Terran Federation, someone invents a normal-space moon-train. Possibly an eccentric genius, or millionaire, or both in one. This person would then make Jules Verne's vision a reality, some centuries after the fact. He or she could even give the train a name in the style of Verne's era, like the 'Luna Express'. Such an event would certainly make the "Pan-Federation Telecast System" news.³⁰ The concept would be whimsical and romantic, and could therefore capture the public's imagination.

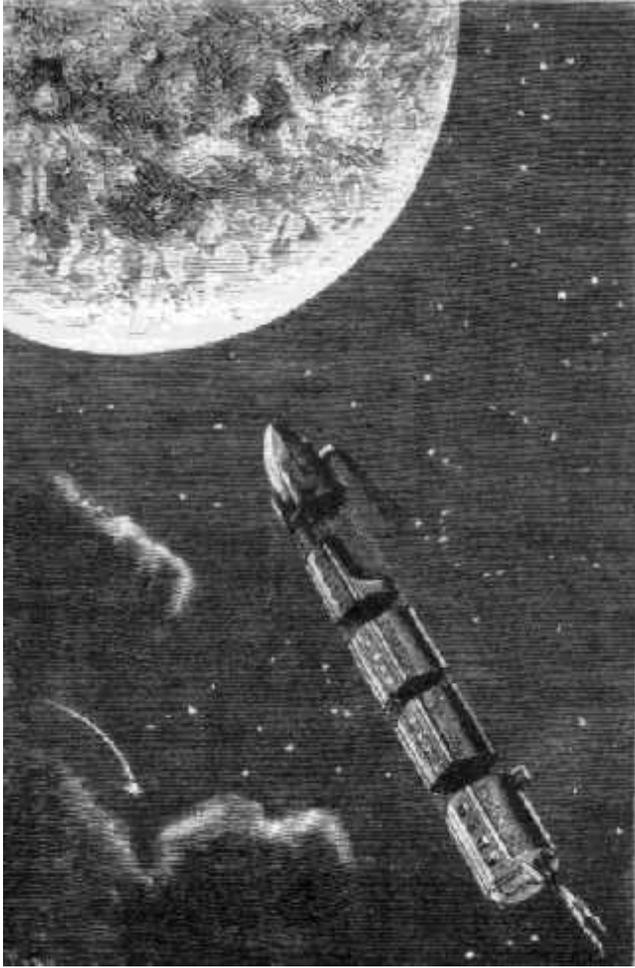


Figure 5. Lunar projectile train, possible inspiration for a Federation-era contragravity moon train.³¹

Compared to the typical spherical spaceship, however, a moon-train would feel somewhat cramped, even if the diameter of its cylindrical cars is much wider than the rectangular ones of conventional trains. Its service on the Terra-Luna run could therefore be a passing fad, or perhaps is relegated to a 'niche' market, similar to the trolley cars and horse-drawn carriages that still survive here and there in our time. Charming relics of a bygone era.

By extension, the success of the moon-train could induce our postulated rich genius to take the next step, and invent a *hyperspace* train. That too is possible, because Beam's flying submarines can be similarly converted. "A hunter ship is heavy and it is well-armored—install hyperdrive engines in one, and you could take her from here to Terra".³² But although it might work, a hyperspace train would probably never catch on. Part of the charm in riding the rails is looking out at the scenery. You could do that in a normal-space train, but the window-views in hyperspace would be nothing but "vacantly gray".³³

It must be admitted that the same will hold true for the underground trains; the gray view this time consisting of vitrified stone. So the hyperspace train could also find a niche; in the trans-solar market, taking people on sight-seeing tours of the celestial bodies within our Solar System. As with the normal-space train, however, most people will undoubtedly prefer the regular spherical hyperspace 'cruise ships', that contain much more room, and can therefore provide more comforts, services and activities.

Space trains could also fit into one of Conn Maxwell's statements about Poictesme. When the search for Merlin takes them into space, Conn's company begins converting the contragravity airliner *Harriet Barne* into a spaceship. At the same time, another company starts cannibalizing four freighters to create

a single cruciform-shaped ship, “like an old-fashioned pre-contragravity winged airplane”, while a third is demolishing a block of old office buildings to construct a ship out of the structural steel. Conn observes, “Well, till we can get a shipyard going on Koshchei and build some real [spherical] spaceships, there are going to be some rare-looking objects traveling around the Alpha System. I wonder what the next one’s going to look like—a flying skyscraper?”³⁴

—Or perhaps a flying train.³⁵

As a whole, the burrow-worlds probably employ a variety of subsurface transportation. After the fall of the Terran Federation, most of them adopt a monorail or even standard dual-rail system in the tunnels between their burrow-cities. But on at least one burrow-world (such as Lakshmi; see below), a few engineers envision something better, and invent a contragravity train. Indeed, just as our postulated rich Federation genius was inspired by the centuries-old works of Jules Verne, some centuries later these post-Federation engineers may in turn be inspired by an historical account of the eccentric contragravity moon-train, which flew for a time between Terra and Luna, back in the more halcyon spacefaring days. Gleaning what information they can from available and surviving sources, these interregnum engineers extrapolate or reinvent the rest, and then add some modifications to adapt the space train for the narrow confines of subsurface travel.

Now, let’s return from this tangent to our main topic of discussion.

e) Time to Dig

During the Interstellar Wars, planets were probably not constantly attacked, and we know that Space Viking raids are not continuous. When Lucas Trask first visits Amaterasu, the last raid was “twenty years ago”.³⁶ Thus, the time between Viking raids, or a short lull in the storm of the Interstellar Wars, would provide the chronological ‘window’ necessary for threatened planets to scramble and build their underground cities, which would really be civilizational fortresses. Twenty years would seem enough time, though Viking raids are of course unpredictable, and truces during the Interstellar Wars were probably broken. With luck, the inhabitants of these planets will be nearly impregnable by the time their foes return. But, as is the way with such things, luck will run out for some. A few are caught in the middle of their planet-wide building projects, and these worlds accordingly pay a heavy price.

By definition, the spaceport ‘pit’ on Fenris is mostly underground, so I would assume that the burrow-worlds which retain space travel finish the job, by roofing their spaceports over. Probably with great collapsium doors, or something like a movable stadium roof. In this way, a burrow-city could become totally fortified. Just about the only way it could be raided by Space Vikings would be by a ground assault, seizing the shaft-heads and then fighting their way down, level by level. Much like the allied assault on the Royal Palace at Malverton, in *Space Viking*,³⁷ and almost certainly a very bloody undertaking. Alternately, the invaders could try subterfuge; disguising one of their ships as a legitimate merchantman, or capturing another planet’s trading vessel—such as a Gilgamesher (see below)—to get into the underground spaceport, in a Trojan Horse-style operation.

f) Light A Fire Under Them

In the case of a Space Viking raid on a burrow-world, the Vikings will eventually leave. Landing on an uncivilized planet and hanging around is one thing—like “Captain Niall Burrik, of the *Fortuna*” does on Melkarth³⁸—but an underground civilization would certainly jump you at the first opportunity. Given the expertise these people must have gained in building the underground transportation system, they could potentially tunnel right under a landed Viking ship that has lingered too long (perhaps disabled in their raid and making repairs, or just arrogantly disregarding the threat from these ‘neobarbs’), and set off one hell of a nuclear bang. That would be a new twist to the old tactic of tunneling under an enemy’s fortifications, and setting off a large cache of explosives, creating a breach through which your troops can storm.

To mask the tunneling operation, the natives could occasionally launch desultory air and ground assaults, keeping the Vikings’ attention on the surface. Once the underground preparations are complete and the nuclear fuse is lit, the resulting blast should at least seriously damage the ship. The landing legs would almost certainly be blown off, and some of the blast energy would enter the ship through the open leg-ports, causing internal damage and casualties. And since a landed hypership would be off contra-

gravity, the vessel itself would be hurled upward, leaving the disoriented and injured crew vulnerable to an all-out surface and air attack in the aftermath.

Assuming the blast creates a huge crater—like the nuclear tests of the 1950s in the western US, only bigger—the ship could even fall back down into the hole. A humorous image that comes to mind is of the now-legless ship possibly bouncing once or twice, and then rolling around the slopes of the crater, before coming to rest at the bottom. (If the ship were the *Rubber Ball*, from *The Last Space Viking*, it would then live up to its name.) And if it wasn't disabled before, the Viking ship certainly would be now, perhaps seriously enough to become a sitting duck for the vengeful locals.

3. A Civil War Burrow-World

a) *Civil War on a Burrow-World*

However, a burrow-world could later lose its civilization if the natives begin fighting among themselves. Terro-Humans being what they are, at least one burrow-world would have a civil war, meaning that going underground only prolonged their civilization, rather than saving it. A civil war could occur in many ways, for example beginning with disputes over the fair distribution of surface and/or subsurface resources. Certain continents are richer in certain resources than others, so 'continental' political parties could arise. In fact they may already exist, if after leaving the Federation the planet is a union of member continents, similar to "the Confederate Continents of New Texas", in *Lone Star Planet*.³⁹ And since some continents are larger and/or more populous than others, they will contain more burrow-cities, giving them more influence in the planetary government. That will of course enable them to manipulate government policies in their favor, which smaller or less populous continents will resent and resist. The result will be a renewal of nationalism, in the form of 'continentalism'. The planet's unified political system eventually fractures, and intercontinental wars follow, probably atomic.

Now, let's bring the Space Vikings back into the equation, which would create a variant of that scenario. Several centuries after going underground, one burrow-world is on the verge of civil war when the Space Vikings arrive and attempt to raid the planet. The Vikings are repulsed—or maybe they eventually give up, given the planet's strong defensive posture—but the destruction of one or two burrow-cities elicits the charge of treachery. Someone must have aided the Space Vikings in their raid; who was it? A rival continent, with whom they already have serious disputes! And perhaps the charge is true (as on the planet Amaterasu, when the nations of Eglonsby and Stolgoland covertly try to use the Space Vikings against each other⁴⁰), or at least is founded on a misperception of truth (defeated by the fierce defenses of one continent, the Vikings are more successful—or more vindictive—attacking another). In overall terms, the planet gets off pretty lightly from the raid; thus, the subsequent nuclear civil war is a most regrettable outcome. Their ancestors' decision to move underground would have saved their civilization, if the citizens of this burrow-world had held fast and not let relatively minor political differences divide them in the aftermath of the greater threat.

This case would therefore be a reverse of what happened on Aton, where a Space Viking raid actually did the locals a favor. As King Mikhyl of Marduk describes it, "That [six-ship Viking] raid saved civilization on Aton. There were four great nations; the two greatest were at the brink of war, and the others were waiting to pounce on the exhausted victor and then fight each other for the spoils. The Space Vikings forced them to unite. Out of that temporary alliance came the League of Common Defense, and from that the Planetary Republic...they'll never go back to divided sovereignty and nationalism again. The Vikings frightened them out of that when the dangers inherent in it couldn't."⁴¹

But a burrow-world, more or less secure from the worst effects of a Viking raid, would probably not be as frightened. Particularly if the planet is not one that has received much attention from these off-world bandits, and/or if the postulated raid consists of only one or two ships. Space Vikings as a whole might not be perceived as a huge threat, contrary to their ancestors' fears. Local planetary rivals would be seen as the greater threat, and the failed Viking raid ironically leads to the end of this planet's civilization.

b) *Subsurface Warfare*

Civil war on a burrow-world would not only involve the usual ground and air forces, but also *sub-surface* forces. Indeed, since the burrow-cities are designed to be well-protected against air attack,

the logical alternative is tunnel warfare. This would be similar to the trench warfare of WWI on pre-Atomic Terra, though on a much larger scale, and completely underground. Instead of trenches and counter-trenches, you would have tunnels and counter-tunnels.

It would also parallel the railroad-based warfare of the US Civil War, because among the first battles to be fought would be for control over the existing transportation tunnels, to allow invasion forces access to the enemy's burrow-cities. But in the same manner as blowing a bridge, the defenders could blow certain tunnels to slow an enemy's advance. This would necessitate re-vitrifying the tunnel, or boring a new tunnel around the obstructed passage.

Of course, the defending city wouldn't just sit idly by while that happens. Piper's character Jack Holloway uses a handheld microray scanner to look into rocks for sunstones. "The first chunk he cracked off had nothing in it; the scanner gave the uninterrupted pattern of homogenous structure... On the fifteenth chunk, he got an interruption pattern that told him that a sunstone, or something—probably something—was inside."⁴² So the burrow-worlds would develop a much larger military-grade microray scanning station, plus advanced seismic detectors, to see and hear great distances through solid rock. These devices would alert them to the enemy's tunneling operations, triggering the boring of counter-tunnels, to block their advance.

Parenthetically, one key element of warfare is accurate geographic information; that is, maps. And building an underground civilization would require an accurate knowledge of subsurface strata and fault lines, at least in the areas of the proposed burrow-cities and their connecting tunnels. Thus, the deduced advances in seismic and microray scanning are most likely initiated when the underground civilization was first built, and these technologies are probably paralleled on the other burrow-worlds. Such maps would be very accurate around the burrow-cities and along the intercity tunnels, but there could still be vast subsurface regions whose geology is relatively if not completely unknown. However, a newly-subterranean people would undoubtedly make an effort to increase their knowledge in this area, especially with regard to discovering new natural resources as well as sites for future burrow-cities. Eventually, the physical structure of the entire planetary lithosphere could be mapped; a futuristic dream even in the early Twenty-First Century on Terra.

It would therefore be later, when a worldwide civil war begins to loom, that the military forces of the various continents begin to utilize this information, and these technologies, in their war plans against each other.

If the enmity between continents is great enough, the purpose of certain tunnels would not be invasion, but destruction of the enemy city. Achieving that objective could involve vitrifying a new tunnel to a known fault line, and setting off a nuke, causing an earthquake that would devastate a burrow-city imprudently built not too far away. Earthquake epicenters are usually deep underground, and the ordnance employed to trigger one could be a planetbuster, or several conventional nukes placed at strategic deep points.

Another tactic would be to try and create a subsurface breach, which could flood a burrow-city built not far from an underground aquifer, or constructed below sea level along a coastline. Such sites would be desirable for the water they can provide a burrow-city, although one near the coast would also need a desalination plant, to purify the seawater. And in fact, the cities at these locations should already have specific tunnels dedicated to the transportation of their water supply. Thus, the enemy operation would attempt to destroy any locks along these 'aqueduct tunnels', and in the city's cistern area, creating a continuous and nearly unstoppable flow of water, potentially drowning the burrow-city.⁴³

And if the burrow-worlders can vitrify tunnels for hundreds of miles *horizontally* between cities, then they could certainly also go *vertical*. Thus, a third tactic would be to deep-vitrify a tunnel down to a magma chamber or even the mantle, creating a passage for a volcanic eruption, totally destroying the enemy city. It wouldn't necessarily be a suicide mission, either. The tunneling vitrifier could stop short of the objective, and leave a very large high-explosive shaped charge. Once the tunnelers are safely away—probably down a side-tunnel, which they vitrify into and then blast closed behind them—the charge would be detonated, removing the thin barrier of rock to the magma chamber, and triggering the eruption. Compared to the magma chamber, the vertical vitrified passage would be extremely narrow, which would increase the speed of the rising magma, in the same way that putting your

thumb over the spout of a garden hose increases the water pressure. Of course, some natural eruptions are non-explosive, and consist of slowly-outflowing magma. So to insure the force of the eruption is great enough, a collasium-plated nuke could be set atop the shaped charge. Once the charge breaks through the thin layer of rock below, the nuke would fall into the chamber, sink to a predetermined depth in the magma, and then detonating.

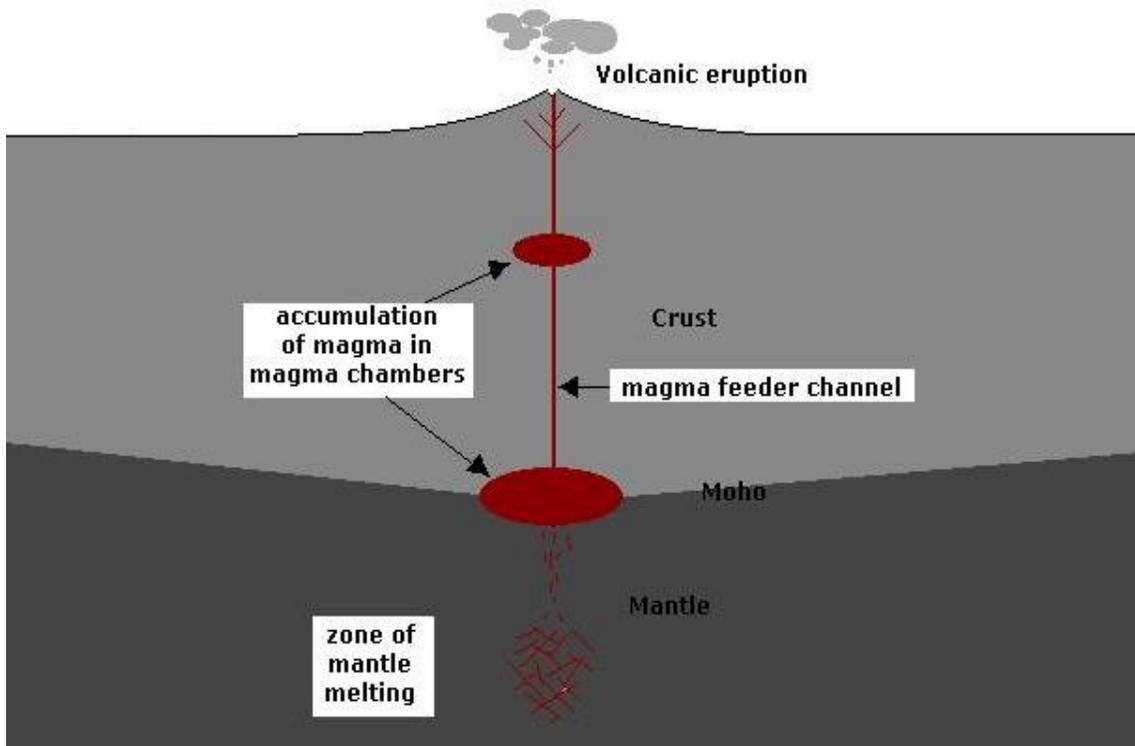


Figure 6. Magma chambers down to the mantle. ⁴⁴

The burrow-worlders would probably have to dig deeper, anyway. If you move underground to avoid aerospace warfare, where do you move to avoid tunnel warfare? Deeper into the planet! So burrow-cities would likely also build deep redoubts, as a final refuge if their burrow-city above is captured or destroyed. These deep redoubts would certainly be stocked with supplies, but also a tunneling machine. You wouldn't want to live down there indefinitely, and if the enemy captures your city rather than destroying it, they could use explosives to destroy the access tunnel, sealing you down there forever. Or, if they do destroy your city, they could then simply drop a nuke down the access tunnel, finishing you off. So another way of escape would be a necessity.

The defense of a single burrow-city could include building a system of fortress-caverns around it, at different distances and depths, and in different directions. These would contain seismic detectors and microray scanners, alert to enemy tunneling operations, as well as being forward operating bases for tunnel operations of their own. A three-dimensional underground defense grid. Nor would the inhabitants neglect surface and aerial warfare in this system. An old-fashioned land invasion could lead to foreign troops knocking on your top door. And if the enemy not only has planetbusters but hellburners, they could spare the troops and just drop a Bethe-cycle bomb on your head, turning your burrow-city into a big smoking crater.

c) Tunnel-Missiles

Another way to destroy an enemy burrow-city would be by launching nuclear missiles *horizontally*. This tactic would utilize the existing underground tunnel network. In a vacuum tunnel, a planetbuster or

hellburner could certainly achieve supersonic velocity, arriving in mere minutes. Of course, that assumes the tunnel is perfectly straight; in a non-linear tunnel, the missile could be loaded onto a vacuum train, which though high-velocity would take a bit longer to travel the same distance. You would have to secure it anyway, since there is little room to maneuver in a tunnel, and the missile going even slightly off-course would not reach its target. Moreover, any nuclear weapon colliding with the tunnel early in its flight would have catastrophic results for the city that launched it.

On the civil-war burrow-world, it is therefore likely that weapons development programs are initiated to create dedicated 'tunnel-missiles', specifically designed for such warfare. An initial design would be an advanced version of our own era's rocket-sled, essentially a stripped-down vacuum-train carriage mounted with a missile. The missile would provide the motive power, while the carriage would keep the missile on course along the tunnel, whether linear or not. That would hold true whether the carriage travels along a monorail, or levitates using contragravity. The Gyronaut depicted above resembles a rocket, so an advanced design would actually combine the carriage with the missile. The resulting tunnel-missile would look much like an underground train, with a warhead where the control cabin should be, and a rocket engine or other motive force at the rear. (Figure 7.)

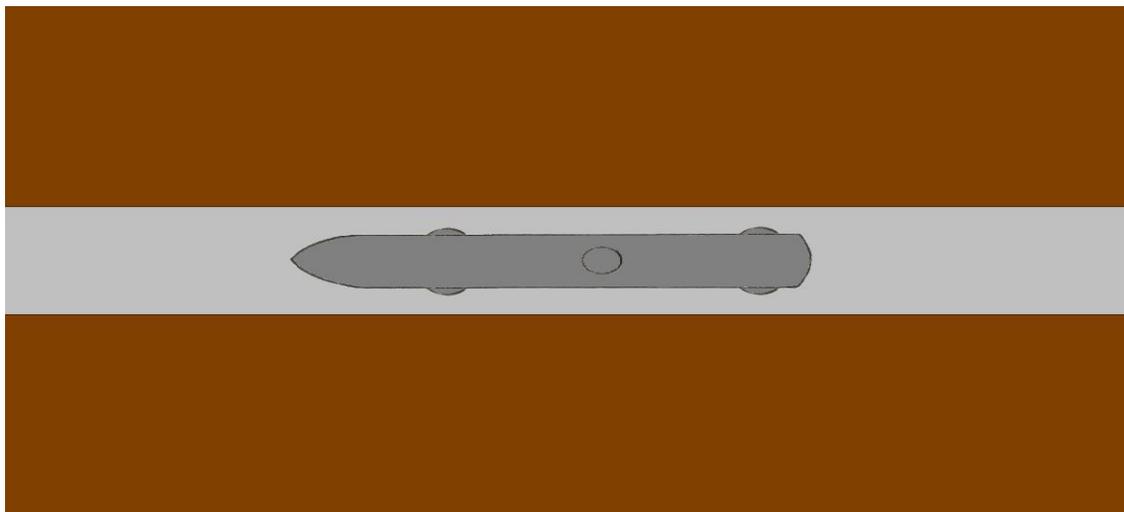


Figure 7. Contragravity tunnel missile.

The invention of tunnel-missiles for offensive operations would naturally lead to the creation of defensive measures. As stated above, one method would be to blow the tunnel, and the threat of an incoming nuclear missile would provide an even better reason for doing so than against an incoming invasion force. But unless the entire tunnel is destroyed, which may be impracticable given their up to intercontinental lengths, that would only be a delaying tactic. A second defensive measure would therefore be the development of 'counter-tunnel-missiles', to destroy tunnel-missiles before they arrive. Static defenses for the burrow-cities would include fitting the transportation tunnel entrances with collapsium-plated blast doors, which would be activated in emergencies to seal the city against incoming tunnel-missiles. Indeed, for vacuum tunnels with airlocks at either end, the airlock doors could be reinforced and double as blast doors.

For more conventional invasion warfare, a less destructive option than a horizontal nuke would be needed. So another tunnel-missile would be designed just to breach these blast doors, allowing collapsium-armored military trains to enter the enemy burrow-city, disgorging troops and small armored contragravity combat vehicles. The entry of this invasion force would be slightly delayed, since breaching a tunnel airlock would have the same effect as breaching one on a spaceship; an intense rush of air would flow out from the city. The defensive response to this new threat would be multiple blast-doors, to keep the breaching-missile from getting all the way through. In turn, that would cause the creation of advanced breaching-missiles, capable of penetrating several blast-doors. A higher order of our own time's 'bunker-busting' munitions.

Given the three-dimensional aspect of underground warfare, the ideal solution for a burrow-world having a civil war would be to completely surround the burrow-cities with collapsium. But that would probably be incredibly expensive, not to mention difficult. It would be like trying to build a miles-wide spaceship shell underground, after you've already built the insides. So it is more likely that the much smaller fortress-caverns around the burrow-city are so armored, as well as strategic points along the city's edge, such as the transportation tunnel entrances, with their blast doors.

Assuming the fortress-caverns around the burrow-city are entirely collapsium-plated, that means some of them could survive when the postulated 'volcano-warfare' begins. Even though the burrow-city they were built to defend is destroyed in a purposely-triggered eruption, the collapsium around the fortress-caverns would keep the magma out, though we'd have to assume that the eruption didn't also destroy the surrounding rock. But for how long the people inside an isolated fortress-cavern could survive, that close to an active volcano, is somewhat problematic. If they have a tunneling vitrifier, they could bore their way out. Alternately, the eruption could create fissures in the surrounding rock, which their microray scanners could potentially detect, allowing them to walk, climb or fly out, depending on what equipment they have.

However, if the burrow-world still has space travel, or at least salvaged a few ships or pinnacles from Federation times, then some of these fortress-caverns could actually be buried spaceships. That would make escaping even easier, especially if the ships were not actually buried, but were simply set down in a landing pit that has been roofed over and fortified. Like the *Nemesis*, these buried ships probably have "pretty fair detection",⁴⁵ so the deduced seismic detectors and microray scanners could be added to the ship's other detection systems, augmenting its capabilities and making it a valuable part of any burrow-city's defensive grid. Indeed, its position just below the surface should enable the ship's standard detectors to search for enemy aircraft and spacecraft, while the newer detectors monitor the subsurface. And as a landed ship rather than immovable cavern, such a vessel could be launched to join the fighting topside, if necessary.

d) Lithospheric Total War

As we've seen, the nations of a lithospheric civilization would engage in lithospheric warfare. At its extreme end, total war would include the deliberate triggering of earthquakes and volcanoes, creating tsunamis and possibly causing climate change. This could do a great deal of damage to their planet's crust and biosphere, even without above-ground nuclear warfare.

Such warfare is actually a logical extension of an event that Piper includes in *Uller Uprising*. At the beginning of the story, Uller Company scientists purposely trigger nuclear devices on Niflheim, causing volcanic eruptions for mining purposes. As described by one of them,

"These volcanoes have been dormant for, oh, maybe as long as a thousand years; there ought to be a pretty good head of gas down there...Hydrogen. That's what's going to make the fireworks; it combines explosively with fluorine...In about half an hour...the real fireworks should be starting. What's coming up now is just small debris from the nuclear blast. When the shock waves get down far enough to crack things open, the gas'll come up, and then steam and ash, and then the magma. This one ought to be twice as good as the one we shot three months ago; it ought to be every bit as good as Krakotoa, on Terra, in 59 Pre-Atomic."⁴⁶

The blast is successful, not only causing another Krakatoa, but "a first-class earthquake" as well, consisting of "About six big cracks opening in the rock-structure".⁴⁷ In celebration, the scientists share a drink, and call themselves "the first A-bomb miners in history".⁴⁸ The word 'first' suggests that they will not be the last, confirmed in *Little Fuzzy*, when Jack Holloway remembers his various prospecting digs. "He could recall at least a thousand blast-shots he had fired back along the years and on more planets than he could name at the moment, including a few thermonuclears".⁴⁹

Nuclear weapons can certainly be put to less peaceful purposes than mining. So one can postulate many subsurface hydrogen bombs causing many Krakatoas and first-class earthquakes at the same time, on a civilized burrow-world. An underground nuclear war, in effect; squared or even trebled in power. To picture the effect, just imagine Krakatoas going off under New York, Moscow, Peking, New Delhi, London and Tokyo, and first-class earthquakes or firestorms hitting Berlin, Paris, Rome, Shanghai, Los Angeles, Bombay, Calcutta, Madrid, Mexico City, Rio de Janeiro and Buenos Aires! And if we include the new class of 'supervolcanoes' that scientists have discovered since Piper's time (Figure 8), the result could

make a nuclear winter—or even “the end of civilization in the Northern Hemisphere”, for that matter—look positively mild by comparison.

A supervolcano is a volcano capable of producing a volcanic eruption with an ejecta volume greater than 1,000 cubic kilometers (240 cubic miles). This is thousands of times larger than most historic volcanic eruptions. Supervolcanoes can occur when magma in the Earth rises into the crust from a hotspot but is unable to break through the crust. Pressure builds in a large and growing magma pool until the crust is unable to contain the pressure. They can also form at convergent plate boundaries (for example, Toba) and continental hotspot locations (for example, Yellowstone)...

Although there are only a handful of Quaternary supervolcanoes, supervolcanic eruptions typically cover huge areas with lava and volcanic ash and cause a long-lasting change to weather (such as the triggering of a small ice age) sufficient to threaten species with extinction...

The term “supervolcano” was originally used in the BBC popular science television program *Horizon* in 2000 to refer to eruptions of this type. That program introduced the subject of large-scale volcanic eruptions to the general public.⁵⁰

Thus, some years after the postulated raid that ignited the planetary civil war, a larger and better-prepared flotilla of Space Vikings could return to try and raid this burrow-world again, only to discover complete devastation. Great gaping holes mark where some of the burrow-cities used to be, and there

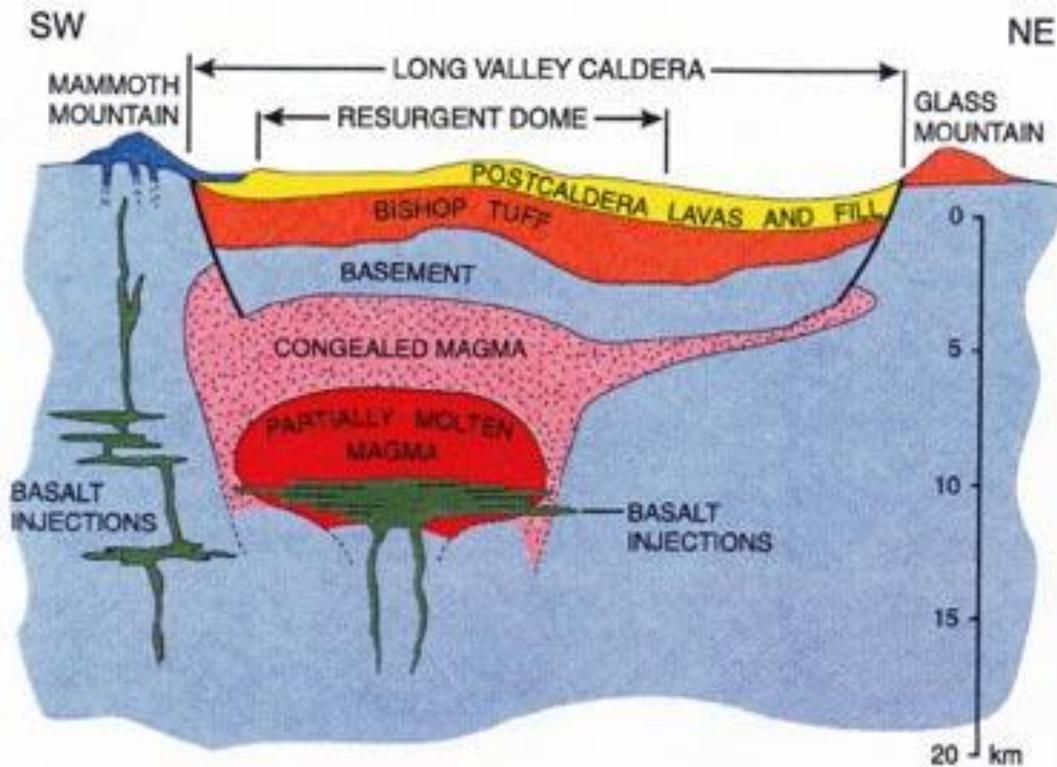


Figure 8. Cross-section of potential supervolcano; Long Valley caldera, eastern California.⁵¹

is evidence of catastrophic worldwide fires and flooding. Moreover, quite a few active volcanoes, a couple of them very large, have covered huge areas with lava, and are spewing great clouds of ash, which has cooled the planet. It appears to be heading into an ice age, and much of the planet’s life has already died out. The few human survivors they are able to observe are quickly reverting to barbarism, if not extinction.

4. A Strip Mine Burrow-World

a) *Living in a Mine*

Piper's mining and manufacturing worlds seem to be usually uninhabitable (Niflheim, Koshchei, even the Moon of Tanith), but the most successful of the postulated burrow-worlds could actually be a habitable planet with rich mineral resources. A Niflheim or Koshchei with life. As such, it would already possess large quantities of mining and earth-moving equipment, even before the Federation collapses. Unlike Fenris, that means the planetary government wouldn't go bankrupt in building the burrow-cities. Moreover, the location of these sites could suggest themselves, in the great holes of its strip mines. A burrow-city built in a strip mine would seem to neatly combine natural resources, manufacturing, and residential areas in the same place. Being rich in minerals and metals, including gold and silver, this planet would naturally be a target for Interstellar or Space Viking ships eager to plunder its wealth, and probably suffers several raids before its civilization moves underground.

Rather than submit to more attacks, and possibly even decivilize entirely, the planetary inhabitants decide to build burrow-cities in the strip mines, and cover them over, like Port Sandor on Fenris. And for added protection against these overhead threats, it would certainly make sense for the burrow-worlds to cover their cities with a dome or at least layer of collapsium.

Of course, Port Sandor—and the other original burrow-cities of Fenris—were not designed with Space Vikings in mind, so for obvious defensive reasons, the majority of burrow-worlds would probably build their cities deeper into the planet. Moreover, as populous, civilized worlds, their underground cities would presumably be much larger than those on Fenris. Port Sandor “was built for a quarter of a million” people,⁵² so the cities of the burrow-worlds could be designed for a million or more. However, even though that would make them four times larger than Port Sandor, they would still not be as large as the cities of Asgard or Malverton. Though in fact, if future history had gone a little differently, the burrow-worlds would have remained fully civilized planets, comparable to Odin or Marduk.

In the case of the habitable strip mine planet, the continued mining, both outward and downward, would provide room for population expansion. Thus, the planet might not merely survive underground, but prosper. The spoil and slag from mining and manufacturing would be deposited on the surface, adding more layers of protection for the people below ground. Indeed, the result could eventually resemble a gigantic anthill. But the natives would be careful not to bury the shaft-heads, so the detritus is probably smoothed out and vitrified to prevent it from sliding.

Their worldwide building project could be aided by the arrival of some Federation forces, including several construction battalions, who are either fleeing defeat in another system, or were invited (and paid) to come by the planetary leaders. By this time, the Federation Armed Forces are falling apart, and still-existing units must decide where to place their fortunes and future. Their arrival would be a great boon to the cause, since the troops can defend the strip mine planet while the construction project proceeds, and the Federation ‘Spacebees’ can use their expertise to help make the burrow-cities well-nigh impregnable, as well as camouflage their locations. The latter would be necessary, since Federation-era maps of the planet may include these sites, and potential raiders could have access to this information.

These battalions will certainly possess the knowledge of how to build large underground installations, and, given the fact that the Interstellar Wars have begun, they may have actual experience in doing so. This would parallel the Third Fleet-Army Force, which designed and built such sites on Poictesme during the System States War. As Conn Maxwell says, “I have maps and plans of all the installations that were built on this planet—literally thousands of them, many still undiscovered...For instance, all the important installations exist in duplicate, some even in triplicate, as a precaution against Alliance space attack.”⁵³

Among these thousands of installations is a duplicate of Force Command Headquarters, which “has everything the other one had, and a lot more, because it'll be cram-full of supplies to be used in case of a general blitz that would knock out everything on the planet. And a chain of hospitals. And a spaceport, over on Barathrum, that was built in the crater of an extinct volcano...And supply depots, all over the planet; none of them has ever been opened since the War.”⁵⁴

All these types of facilities built on Poictesme could later be constructed on the strip mine burrow-world, and linked via an underground tunnel network.

b) The Tectonicon of Lakshmi

For the prosperous strip mine burrow-world, a somewhat different political system is envisioned. Instead of a collection of nations or continents, as on surface dwelling planets or lesser burrow-worlds, the natural lines of division in a fully-successful lithospheric civilization are the boundaries of tectonic plates.⁵⁵ Thus, the strip mine planet is styled the **TECTONICON OF LAKSHMI**. Lakshmi is the Hindu goddess of wealth and prosperity, a name that could be suggested when the original explorers discover the planet's mineral wealth. And Tectonicon is a contraction of both 'Tectonic Contract' (the agreement that put the current political system in place) and 'Tectonic Construction' or 'Construct' (the governing body that runs the planet). For this burrow-world was a truly massive planetary construction effort, and the mining and construction companies, already very influential in Federation times, eventually took over. Lower-ranking political bosses actually have titles like 'Boss'.

As a matter of purely linguistic interest, the invented term 'tectonicon' also combines the two meanings of 'tectonic', a word that not only refers to geology ("of the deformation of rocks: relating to the forces that produce movement and deformation of the earth's crust"), but construction ("relating to construction and architecture"). Tectonic comes from the Greek *tektonikos*; *tekton*, "builder, carpenter", and is the source of the English word 'architect'.⁵⁶

The result is a corporatist civilization ruled by builders and architects. And 'Architect' is in fact the Lakshmanian version of President. The word *arch-* can mean "greatest" (as in arch-enemy) or "ruler" (Greek *archon*). So the Architect of Lakshmi is literally the 'greatest builder' or 'ruling builder'. Politically, the Architect is a secular leader, but the office also has a mystical dimension (see below).

When Lakshmi was first discovered, it was found to be the fourth planet in a seven planet dual-star system. Its rich resources were caused by a unique stellar arrangement.⁵⁷ The current Tectonicon began as a Federation-era Chartered Company. As a life-bearing world, Lakshmi eventually became a Colony and then Member Republic, but the mineral wealth meant that the Company still had great influence. Unfortunately, this led to rampant political corruption, which eventually resulted in a backlash. Crusading citizens and rising young politicians broke up the Company, in a major trust-busting effort.

But when the System States War began, Lakshmi became an important part of the Federation's war machine. The mines went into full production, and manufacturing centers proliferated, converting the raw materials into war materiel. Though no longer a single large entity, the mining, construction and manufacturing companies regained much of their old influence. And later, when the Federation fell apart for good and the citizens decided to move their entire civilization underground, they finally regained supremacy. The construction firms in particular, since they were supported by the ex-Federation construction battalions that had relocated to Lakshmi.

What eventually emerged is an interlocking system of closely related companies and influential families, called 'company-clans'. Something of a cross between the Old Terran Japanese *zaibatsu* (vertical group of businesses and financial institutions, run by a single family) and *keiretsu* (horizontally-associated conglomerates). Things generally run smoothly under this setup, which is sufficiently diverse, decentralized and honest to avoid a repeat of the trust-busting period.⁵⁸ The system is also supported by the Lakshmanian military. Due to the early influence of the ex-TF battalions, many sons and daughters of the company-clans traditionally join the planetary armed forces, usually ending up in leadership positions. The current politico-corporate system is therefore backed by force; a further guarantee against the already-unlikely trust-busting scenario.

Terro-Humans are naturally competitive, and on Lakshmi this instinct has been channeled into a 'constructive' form. The company-clans vie with each other, and even their own predecessors, in building ever-greater works. This has led to such innovations as a worldwide subterranean contragravity train system, unequalled even among the other burrow-worlds. And although atomic power is still widespread, the Lakshmanians now get most of their energy from geothermal sources, via vitrified shafts sunk deep into the planet. For the diversion of its citizens, specialized sports-caverns have been excavated, hosting not only traditional sports, but new contragravity games like sky-squares. And for more leisurely activities, hotels and resorts have been created in and around natural underground caverns of great beauty, with stunning views. Indeed, under one of the shallow Lakshmanian seas a marvelous subterranean system of lakes and rivers was discovered, with its own unique and unusual ecosystem. This was subsequently

declared a Planetary Park, and its development tightly restricted. Nevertheless, it is one of the most popular tourist destinations among the public.

The Lakshmanian artistic class has also made its contribution. The gray vitrified stone of the intercity tunnels was seen as rather drab, so Lakshmanian artists decided to improve the subsurface travelers' experience, by creating a new class of 'high-speed art'. This involved painting long stretches of the tunnel surfaces with highly elongated artwork of any and all imaginable types. For example, once the trains are up to full speed, such art can give the illusion that the passengers are going through an art gallery, viewing reproductions of famous works; or traveling above ground, through the "wide grasslands and...evergreen forests" of Odin during the Old Federation,⁵⁹ or through mountainous Japan on Old Terra before the Atomic Wars, or even along the ancient aqueducts of Old Mars during the time of the Canal-Builders.⁶⁰ Futuristic spacescapes pretend to take the traveling public to imaginative alien worlds, or past a black hole, or close to the galactic core; while optical illusion art makes the tunnel surface itself appear to be moving, twisting or undulating. Even clever epigrams and poetry are displayed in this way.

Historically, excessive building can put strains on a society, not just in financial, but in ecological and human terms. On Easter Island, for example, it is believed that the excessive building of *moai* (stone idols) contributed to the collapse of native society, due to deforestation and its related effects.⁶¹ And in ancient China, the building of the Great Wall during the Chin Dynasty is estimated to have cost anywhere from hundreds of thousands to a full million lives.⁶²

There is therefore a danger of something similar happening on Lakshmi. But the Lakshmanians have put in place an organization designed to prevent that. Indeed, the organization itself was what started this constructive competition.

c) *The Architects of Myth*

Given its corporate and industrial character, the Tectonicon is not surprisingly a purely practical and rational society. Nevertheless, over time it has counter-intuitively taken on a mystical dimension. This began when the Federation failed, and the people of Lakshmi began searching for a new world-view; something to put their faith in. Precisely because the Lakshmanians were a practical people, the existence of the vast and intricate Universe needed a rational explanation. The old and allegedly scientific theory that "it created itself out of nothingness" wasn't good enough. The more one learned about the universe, the more it seemed well-designed rather than randomly created. This feeling was only heightened by the highly unusual nature of the Lakshmanian system, which seemed too providential for mere chance. And perhaps their most important question was, what was Terro-Humanity's role in all this starry vastness?

The Lakshmanians found their answer in the writings of Ilana Kwan, amateur astronomer and professor of philosophy at the University of Mornington, the planetary capital. The new world-view that emerged was adopted by the Tectonicon, partly due to the necessity of restraining the old Lakshmanian tendency toward rampant corruption, once the companies had retaken control. But also to keep the various corporations and influential families working together, instead of fighting each other. That could lead to civil war, and, potentially, barbarism. In any society, a certain amount of chaos and disorder seemed to serve a beneficial purpose, but too much was destructive.

Thus, in order to preserve a prosperous and orderly planetary civilization, and to understand that civilization's role in the Universe, a Masonic-like organization was created. With the differences of being neither exclusively male, nor entirely secret. This organization was a great facilitator in channeling the Lakshmanian peoples' energies into constructive and cooperative directions.

Freemasons are also referred to as members of 'the Craft', and are believed to have begun as a secret society of medieval stonemasons; skilled craftsmen with their own rituals, symbols and lodges. Their traditions hold that they were great builders, having contributed to the construction of some of the most impressive structures of the Middle Ages, including Gothic cathedrals like Chartres.⁶³ Their society was (and is) not a religion, but belief in a Supreme Being is a prerequisite for membership, and God is referred to as "the Great Architect of the Universe".⁶⁴

Since the semi-secret Lakshmanian organization embraces skilled craftsmen (and -women) of all kinds, rather than just stonemasons, it was named the 'Artisanry', and its members 'Artisans'.⁶⁵ Being similarly construction-oriented, the Lakshmanian Artisans have a parallel worldview, save that rather than a single God as in Masonry, they believe the creation of the universe was more likely a collaborative effort. They

have therefore postulated the existence of a number of superuniversal figures called 'Archetypes', seven of which represent the seven main aspects of a construction project. Design, financing, materials, fabrication, transportation, assembly and finishing. As the designer or 'creator' of what was actually built, our Universe, the 'High Architect' is the senior Archetype in this Lakshmanian pantheon.⁶⁶ In Artisanry rituals, the Architect of Lakshmi is considered an analog of this figure, being his/her representative, much as in an established religion such as Western Christianity, where the Pope is styled "the Vicar of Christ".

The indefinitely-sexed pronoun brings us to the fact that the Archetypes are neither male nor female, but for human convenience can be depicted as a man or a woman. Both versions have the same name, but are gender-specific; as in human names like John/Joan, Daniel/Daniella, and so on. Like the Masons and other secret societies, the Artisanry has developed its own rituals and symbols. Among these are hidden allegories between the seven main Archetypes and the seven planets of the Lakshmanian system.

Because the universe is 'finished', its creation having been accomplished billions of years ago, and since construction teams engage in one project after another, the Lakshmanian cosmology holds that the celestial Archetypes are currently off somewhere building other universes. Though beyond human comprehension, these are theorized to be of different sizes, shapes, made out of different materials, and obey different physical and temporal laws.⁶⁷ Hence, the Lakshmanians believe in a multiverse, and the odds are in favor of other universes having been created before ours.

To the Lakshmanians, this line of reasoning explains why mankind's search for God has failed, since that search is necessarily restricted to this universe. On the other hand, people who were involved in a major construction project sometimes return to admire their handiwork, so the Artisans also believe that the Archetypes occasionally return to our cosmos. It could be tomorrow, or a million years from now. But they're a bit ambivalent about that occurring. Constructs such as buildings are sometimes demolished to make way for something new, and the Archetypes could decide to do something similar to the Universe.

Even if they don't do anything so drastic, the universe may not be eternal. Nothing built by Terro-Humans lasts forever, and it may be the same with the Archetypes. Though the present cosmos will probably continue to exist for billions of years, the likelihood of its ultimate ending is variously interpreted by the Lakshmanians as either the 'design life' of the universe, or perhaps a sort of Archetypal planned obsolescence. In this regard, one of the cosmological theories among Terro-Human scientists postulates that the universe may end in a 'Big Crunch', a reverse of the Big Bang which is believed to have created it. The Artisanry therefore entertains the possibility that the Big Bang itself followed an earlier Big Crunch, in which a previous universe was purposely destroyed by the Archetypes, to make way for the present one. In Lakshmanian-construction terms, this ancient Big Crunch would have been an 'implosion-demolition'. Black holes, whose ferocious gravities pull in all energy and matter around them, are therefore viewed by some Artisans as demolition-charges, set to eventually bring down our own Universe. (Though not a happy prospect, the Lakshmanians felt obliged to add an eighth Archetype, a destroyer called the Irrevocable Leveller, to the pantheon.)

As well as not lasting forever, the finished product of a human construction project usually doesn't move; whether a skyscraper, power plant, sports arena, spaceport, or burrow-city. So there is a segment of Lakshmanian society that views the universe, with its majestically pin-wheeling galaxies, blazing multi-colored stars, swiftly rotating planets of various sizes and orbits, exploding supernovae and imploding black holes, as less a construction project than a work of art. This group adds a 'Great Artist' to the pantheon of Archetypes, placing him/her above even the High Architect. Naturally, the Lakshmanian artistic class belongs to this societal segment, since artists create for the sake of creating, rather than for purely practical reasons. Other nonconformists on Lakshmi (known as 'Contravenals') also gravitate to this group. For the most part, however, orthodox Lakshmanians ('Conformals') view the Great Artist as another name for the seventh Archetype, the Supreme Completer, or one of his/her Acolytes. The latter group being a postulated class of numerous subordinates, which assist the Archetypes in their endeavors.

Incidentally, I used to wonder if Piper himself was a mason. In *The Cosmic Computer*, Rodney Maxwell is forced to let Wade Lucas in on the Awful Truth about Merlin. As Rodney puts it, "I had to...He'd figured most of it out for himself. The only thing to do was *admit him to the lodge and give him the oath.*"⁶⁸ That's almost certainly a Masonic reference. And it turns out I was partially correct, as John Carr's 2008 biography reveals that Beam's father was a mason.⁶⁹

d) Raid, Raid Again

With its wealth of resources, Lakshmi has been too desirable to resist. Thus, even after moving underground, the planet has periodically suffered raids, both during the Interstellar Wars and the Space Viking Age. The initial raids plundered or destroyed all the surface cities, and the few Federation-era hyperships the Lakshmians possessed (notably from the arrival of the ex-TF battalions) were lost in the fighting. The later raids on the burrow-cities include the examples mentioned in **Time to Dig** above. Several have been straight-down-the-shafts invasions, very bloody and not very successful. Another such raid was a Trojan Horse operation, in which a merchant hypership from Gilgamesh was 'space-jacked' by Space Vikings, and bluffed its way into an underground spaceport. This raid was rather more successful, although a second attempt with the same tactic found that the Lakshmians were now alert to this sort of thing. The Vikings barely escaped with their lives.

Moreover, these particular Space Vikings subsequently had a substantial price put on their head, by the righteously indignant government of Gilgamesh. The Gilgameshers are aware that they are "generally disliked" by other Terro-Humans,⁷⁰ and when word of the spacejacking got around to other planets, all of their ships became suspect. On many civilized and semi-civilized worlds, the incident became an excuse to subject Gilgamesh traders to increased scrutiny if not downright hostility. Landing and berthing fees were increased, sometimes dramatically, as 'insurance' that these Gilgameshers were legitimate. Although they are used to being disliked, the increased fees and loss of trust were bad for business, so the Gilgameshers put top priority on punishing the offending Vikings, and thereby restoring their interstellar reputation (such as it is) as neutral traders. They couldn't do the punishing themselves, as the only time Gilgameshers actually fight is "with fanatical ferocity in defense of their homeworld".⁷¹ So an armed expedition was out of the question. And given the sheer scale of the Old Federation, such an expedition would most likely be a failure, anyway—and an expensive one at that.⁷² The best option for the Gilgameshers was to offer a reward big enough that someone else would do the job for them.

A third type of Viking raid on Lakshmi was the most successful. This involved dropping a low-yield Bethe-cycle bomb right on top of a burrow city. Well, actually just above; it was set to detonate in the air. Thus, the fusion reaction did not destroy the burrow-city, but did strip away the layers of slag and part of the collapsium dome, creating a large breach. Many people in the upper levels of the city were killed from the blast and radiation, and once the fusion reaction ended (not hours later like a hellburner, but only lasting some minutes), the Space Vikings swarmed down into the breach in their armored contragravity vehicles. Making their way to the perimeters of the city where the mines and factories were located, they secured a great deal of plunder. And anticipating the inevitable counterattack from other burrow-cities, they also blew out or blocked up several of the city's tunnel-entrances.

But they were forced to withdraw when Lakshmi troops began arriving by the contragravity trainload through several unblocked tunnels, whose entrances were still held by the city's defense forces. At the same time, other Lakshmi teams were clearing the blocked tunnels with tunnel-missiles, explosives and manipulators, with reinforcements ready to storm in close behind. And several new tunnels to the city were being created by vitrifiers from the surrounding fortress-caverns.

Thus, even though the Lakshmians have not had a civil war, their periodic fights with Interstellar raiders and Space Vikings have forced them to develop most if not all of the tools for tunnel-warfare, as described in **A Civil War Burrow-World**.

Up to the Bethe-cycle raid, the Lakshmians were a bit complacent, feeling pretty secure in their underground cities. Their ancestors, including the ex-Federation construction battalions, did their work well; perhaps too well. The occasional shaft-head raids were beaten off with little loss, while the 'Viking Horse' raid was seen as a fluke. But the Bethe-cycle bomb shook them out of their defensive posture. The Space Vikings could easily do the same to other burrow-cities, once their locations are discovered. And even though Lakshmi should fall under the Space Viking category of being "too good a cow...to kill before the milking was over",⁷³ a full-size hellburner could destroy an entire burrow-city. Realizing at last that the best defense is a good offense, the Lakshmians began paying more attention to atmospheric and exo-atmospheric warfare, to intercept incoming Space Vikings before they reach the surface.

In fact, the 'bounce-and-roll' episode, in which a landed Viking ship has a nuclear fire lit under her, also occurred on Lakshmi. The goal was not to destroy the Space Vikings, but to capture them. 'Tectonicon' can also imply 'technology', and the Lakshmians are master builders. So the reason for

capturing the Viking ship and its crew was to gain their technology and expertise, including hyperdrive; and, hopefully, a planetbuster or hellburner. Copying these devices would allow Lakshmi to face future Space Viking raids head on, out in space. The disabled ship was therefore repaired and entered service in a newly-established Lakshman Space Navy. Having lost hyperdrive centuries before, that was one way for the Lakshmans to reacquire it.

Another, easier, method to acquire advanced technology was to 'impound' a visiting merchant hypership from Gilgamesh. Ostensibly, this was for failure to pay landing and berthing fees, which were substantially increased after the Viking Horse operation; but when the money was promised, the Lakshmans came up with some other outwardly plausible yet patently fraudulent reasons to keep the ship. In reality, it was a confiscation in retaliation for the Viking Horse raid—though the raid was not the Gilgameshers' fault, it did occur in one of their ships—and also because of the perceived pressing need to acquire hyperdrive technology. Relations between Gilgamesh and Lakshmi were considerably strained after the raid and subsequent hypership impounding. Indeed, there was even talk of war, although given the Gilgameshers' nonaggressive beliefs (save for the defense of their homeworld), plus the currently-miniscule state of the Lakshman Space Navy, such a conflict was a highly unlikely occurrence.

Concurrent with the creation of the Lakshman Space Navy was the appearance of a Lakshman space merchant marine. The planet's previous defensive posture meant that it relied on the hyperships of other worlds (including Gilgamesh) for its interstellar trade. And because of its rich natural resources, that trade was rather lucrative. As in the case of Poictesme, however, the Lakshmans finally realized that they could greatly increase their profits by employing their own hyperships, and the spike in revenue could pay for the fledgling Space Navy. Moreover, Lakshmi would no longer be dependent on other worlds for its trade, and could begin to make its own mark on the Galaxy. And these objectives were consistent with, and supported by, the world-view of the Artisans.

Thus, like the Gilgameshers themselves, the Lakshmans became fully civilized again, although not strictly through their own efforts.⁷⁴

5. "All Conceivable Levels of Complexity and Technology"

a) *The Future Historical Period*

The postulated class of burrow-worlds described in this paper includes the planets which move, or attempt to move, their civilizations underground, when the Federation breaks up and the Interstellar Wars begin. The number that are successful would not be very large; perhaps no more than ten planets.⁷⁵ Partly inspired by the planet Fenris, which may be the first of the kind, the burrow-worlds are represented here by the unnamed civil-war burrow-world (which destroys itself), and especially the Tectonicon of Lakshmi (the most successful). The burrow-world concept would seem to fit into John W. Campbell's statement about the *Space Viking* period of Piper's Future History. As Campbell put it, "One of the beauties of the set-up you've got is that it allows the exploration of cultures of almost all conceivable levels of complexity and technology. They can be examined either internally or externally—i.e., either by a native, or by a visitor."⁷⁶

I would add; or, by both. Such planets would also continue Beam's precedent in *Space Viking*, where he has Andray Dunnan construct a burrow-world of sorts; an underground base on Abaddon, "the ninth, outer, planet of the Marduk system."⁷⁷

For the postulated burrow-worlds, I've shown a couple possible political systems. But Piper always used historical models, which means that for these worlds to 'fit' into his Future History, we need to establish the correct historical period. And as I state in my paper "Piper's System", the Old Terran Federation is not only modeled on the British Empire, but also on the Roman Empire. This deduction explains why the Federation lasts over ten centuries—because Rome did—while the British Empire only lasted about three and a half. The Roman model also explains the rise of the Neobarbarians and Space Vikings during and after the dissolution of the Terran Federation, which parallel the Germanic barbarians and the Viking Age that heralded and followed the fall of Western Rome.

Beam was using *timelines*, rather than historical models at random. Rome lasted from roughly 500 BC to 500 AD, which parallels the Federation's period of approximately AE 1 to 1000. Thus, the novel *Space Viking* takes place in an 'interstellar medieval' period, and the timelines appear to line up like this.

State	Lifespan	Post-Universal State Events			
Roman Republic	500 BC -- 500 AD	1154 AD late Viking age (Revival of Empire, Church, and Towns)	1167 AD Hanseatic League	1267	1454 AD Renaissance
Terran Federation	AE 1 -- AE 1000	AE 1654 <i>Space Viking</i> (revival of planets, Mardukan Empire)	c. AE 1667 League of Civilized Worlds	c. AE 1767 <i>The Last Space Viking</i>	AE 1954 interstellar renaissance

Figure 9. Comparison of timelines; Western History and Terro-Human Future History.

As seen in the chart, the time of *Space Viking*, which contains the beginnings of a revival of interstellar civilization, parallels the “Revival of Empire, Church, and Towns” of the Medieval period which followed the Dark Ages. Piper modeled the League of Civilized Worlds on the Hanseatic League, and the Mardukan Empire on the Holy Roman Empire. The time of *The Last Space Viking*, about a century after *Space Viking*, would then parallel the time around 1267 AD.⁷⁸

Thus, *Space Viking* and *The Last Space Viking* take place in a future parallel of the High Middle Ages (1000-1300 AD). By extension, a couple of centuries after the latter novel, there will occur an ‘Interstellar Renaissance’, a new and vigorous flowering of interstellar civilization, paralleling the Renaissance period of Western civilization.

b) Lakshmi’s Historical Models

Because the Lakshmians moved into their strip mines and covered them over, and then built new underground transportation routes, and because their surface cities were plundered or destroyed by Interstellar raiders and Space Vikings, the surface of their world is now largely in a natural state. Thus, the historical model of Lakshmi is Switzerland, an Alpine nation with great natural beauty that came into existence during the medieval period.

Switzerland was formally constituted in 1291, when the cantons of Uri, Schwyz and Unterwalden signed the Federal Charter creating an “Everlasting League”.⁷⁹ In the above chart, 1291 AD would correspond to AE 1791, or a quarter-century after *The Last Space Viking*. Thus, somewhere around that time is when the Tectonicon of Lakshmi, plus the civilized planets of several other systems, establish an interstellar league, called the ‘Endless Association’. To outward appearance, ‘endless’ refers to time; the Association will theoretically last forever. But in the semi-secret mythos of Lakshmi, ‘endless’ also refers to space, and the hidden universal mission of the Artisans.⁸⁰

The name ‘Switzerland’ is derived from Schwyz, one of the three original cantons; the name “gradually came to be used for the entire Confederation”, which now includes 26 cantons.⁸¹ The postulated Endless Association could therefore be informally referred to as the ‘Lakshmiian Confederation’, which ultimately includes many star systems roughly centered around Lakshmi.

Swiss pikemen became a fabled part of medieval warfare. They were much in demand as mercenaries, and gave their own country victories over such adversaries as the Habsburgs (“battles of Morgarten in 1315 and Sempach 1386”) as well as “Charles the Bold of Burgundy during the 1470s”. With their success, Swiss infantrymen “acquired a reputation of invincibility”, which “had so impressed Macchiavelli”.⁸² From this element, we can infer that the deduced Lakshmiian innovations in subsurface technology and weaponry could become similarly famous in their future-medieval era.

At the time of its inception, the Swiss Confederation was actually a part of the Holy Roman Empire, so early in its history, the Lakshmiian Confederation should be incorporated into the Mardukan Empire. With its abundant mineral resources and innovative warfare techniques, Lakshmi in itself would be a valuable addition to the Empire.

And in more than just resources and soldiers. Switzerland also became a major financial center, with a banking system legendary for its secrecy. Thus, Lakshmi’s mineral wealth is the foundation of a major interstellar banking system, aided by its secretive yet honorable Masonic-style ruling elite. After the fall of the Terran Federation, and as a future parallel of the Swiss franc, the Lakshmiians adopted a gold-based currency, called the ‘double sol’, or *dosol*. This was modeled on the old Federation sol, but adapted to

Lakshmi's twin-sun system. But the adjective was appropriate for another reason. Due to Lakshmi's mineral wealth, the double sol does indeed contain a higher amount of gold, although not twice as much as the old sol of the Federation. And as a strong currency, the Lakshman double sol was adopted as the standard of the Endless Association, which is an economic as well as defensive alliance. The dosol is therefore another reason the Endless Association comes to be called the Lakshman Confederation.

We have seen that the subterranean Lakshman civilization would be a very tough nut to crack. Individual Space Vikings would be largely unsuccessful in any attempted raid, and it would take a large fleet of ships if the goal is not just plunder but conquest. The burrow-worlds in general, and Lakshmi in particular, might then also fall into the 'better to trade than raid' class of planets, such as Imhotep.⁸³

On the other hand, the rising interstellar powers such as Marduk and Odin are undoubtedly building ever-larger Space Navies, so the capability for conquest is in the process of being created. It is therefore likely that the Lakshman Confederation is eventually induced to join the Mardukan Empire 'voluntarily', though probably under the threat of invasion, and possibly after several 'incidents' between Lakshman and Mardukan warships. The advantages for Lakshmi in agreeing to join the Empire would include full access to Mardukan markets, and protection by the Imperial Navy from encroachments by the other interstellar powers. A concession the Mardukans might be only too willing to give, in order to prevent the Lakshmans from joining the stellar folds of Odin, Isis or Osiris.

However, moving their entire civilization underground also means that the Lakshmans are a proud and strongly independent people. They would therefore insist on a great deal of autonomy, and are not intimidated, despite the Mardukans' veiled threats. Indeed, in their deduced clashes with the Mardukan Empire, the Lakshmans probably give a very good accounting of themselves. This would parallel the Swiss, who were successful against the Holy Roman Empire. "The Swiss victory in the Swabian War against the Swabian League of Emperor Maximilian I in 1499 amounted to *de facto* independence within the Holy Roman Empire."⁸⁴ Elsewhere this Swiss characteristic is referred to as "greater collective autonomy within the Holy Roman Empire, including exemption from the Imperial reforms of 1495 and immunity from most Imperial courts."⁸⁵

By this time, the Mardukan Empire should be pretty powerful, so their defeat at the hands of the 'lowly' Lakshmans would be an unforeseen and unpleasant surprise.

In addition to its Space Navy, which provides the Lakshman Confederation with a robust defense, its location in space could provide an excellent bargaining position. Switzerland currently lies between Germany, Austria, Italy and France; in its earlier history, these were the Holy Roman Empire, the growing Hapsburg dominions, the north Italian city-states, monarchial France and the powerful Duchy of Burgundy. (Figure 10.) So Lakshmi, and its surrounding Associated systems, could be similarly located in a region of space almost equidistant from four or five of the major planets, and border on their 'empires', or spheres of influence. This would make the small but vibrant Lakshman Confederation highly desirable for strategic as well as economic reasons, thereby increasing its value to Marduk.

During the negotiations for accession, the Lakshmans could therefore tell the Mardukans that if they won't agree to certain conditions giving them considerable autonomy, perhaps the governments of, say, Odin, Isis or Ishtar would be more willing to compromise. Indeed, some skillful Lakshman diplomacy, aided by Space Naval maneuvers of the other planets interested in the Endless Association, could induce the Mardukans to grant just about everything, provided that Lakshmi simply joins the Empire.

However, the perceived value of the Association may cause these other major worlds to demand that, if Lakshmi is admitted to the Mardukan Empire, it must be 'neutralized'. In the sense that the interstellar powers like Osiris and Ishtar must also be allowed to retain business and financial dealings with Lakshmi, and that Lakshman troops may not be used against them, in any future conflict with Marduk. This would be modeled on the historical fact that "During the Thirty Years War, Switzerland was a relative "oasis of peace and prosperity" (Grimmelshausen) in war-torn Europe, mostly because all major powers in Europe depended on Swiss mercenaries, and would not let Switzerland fall in the hands of one of their rivals."⁸⁶ A neutralized Lakshmi would parallel the currently-famous Swiss characteristic of 'armed neutrality'.⁸⁷

Moreover, an autonomous Lakshmi would fall under a certain policy of the First Galactic Empire, as described in Piper's story "A Slave is a Slave". Section Two, Article One of the Imperial Constitution declares that "*Every Empire planet shall be self-governed as to its own affairs, in the manner of its choice,*

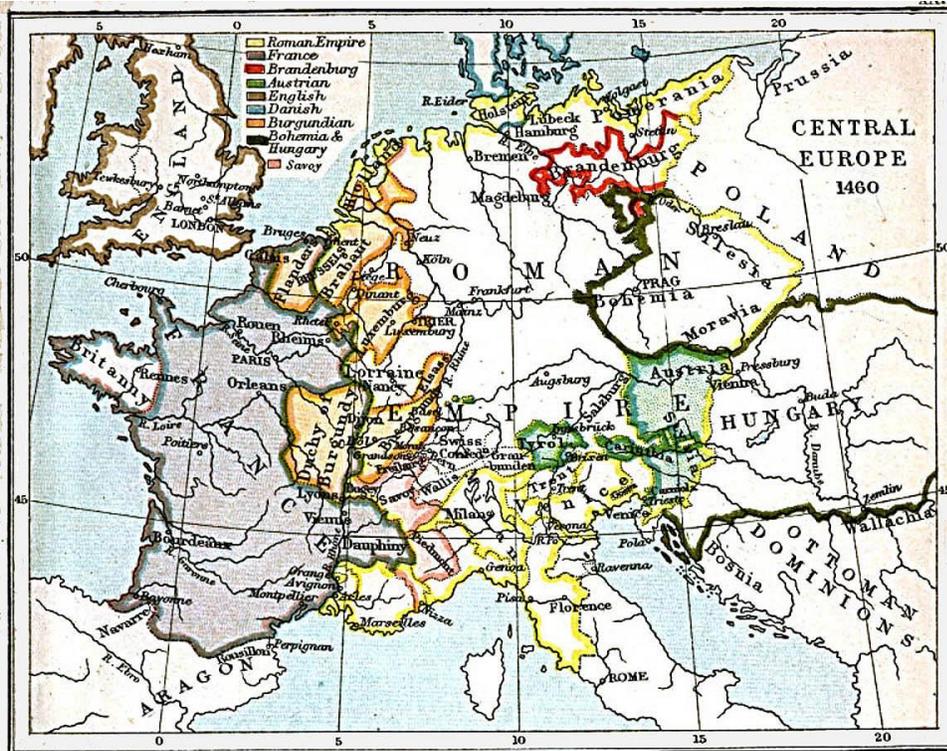


Figure 10. The Swiss Confederation and Central Europe in 1460.⁸⁸

*and without interference.*⁸⁹ As Jurgen, Prince Trevannion puts it, “We will not repeat the mistakes of the Terran Federation. We will not attempt to force every planetary government into a common pattern, or dictate the ways they govern themselves.”⁹⁰

Since “Marduk [is] where the [Galactic] Empire had begun”,⁹¹ this policy may in fact originate with Prince Simon Bentrík, who later becomes the Mardukan King, Simon I. Because when Prince Trask tells him that Sword World feudalism isn’t any better than Marduk’s defective constitutional monarchy, Prince Bentrík replies, “Then we’ll just have to make it work the best way we can, and when it breaks down, hope the next try will work a little better, for a little longer.”⁹² Certainly the best way to make a new universal state last longer would be to correct the mistakes of the previous one, the Terran Federation. One of the Federation’s implied defects was its organization, in which the vast majority of planets started out as chartered companies and colonies, and ended up as Member Republics. Too much uniformity, it seems.

Although Piper does not specify, the Mardukan/Galactic policy of local autonomy may begin due to political necessity. Certainly it must partly result from the great variety of governmental systems on the planets that Marduk annexes, which evolved in different ways after the collapse of the Old Federation. It would be much easier for such worlds to accept Imperial authority if they can keep control of their distinctively local affairs, not to mention much easier for Marduk to annex. But another part of it may be due to weakness. In the early years of their expansion, the Mardukans are not omnipotent; they have other interstellar powers to reckon with. In this, their situation differs greatly from that of the old Terran Federation, which had no external enemies during its expansion phase. Thus, when Marduk desires to acquire a civilized planet or group of planets, like the postulated Lakshmanian Confederation, the competing interests of other interstellar powers would have to be taken into account, thereby forcing the Mardukans into a more negotiable frame of mind.

The nonnegotiable, or more iron-fisted, policies may come later, when the Mardukan Empire is transformed into the Galactic Empire. When the “Imperial Constitution”⁹³ is enacted, probably in AE 1848,⁹⁴ interstellar associations like the Lakshmanian Confederation, formerly subordinate to the Mardukan

Empire, will be dissolved. The Galactic Constitution states that “No planetary government shall make war...enter into any alliance...tax, regulate or restrain interstellar trade or communication”.⁹⁵ Henceforth, Lakshmi and all other planets will be *individual* members of the Galactic Empire, just as individual planets were once Member Republics of the Old Terran Federation. By this time, the Mardukan/Galactic Empire is presumably so powerful that any objections to this policy are effectively futile, if not suicidal. For example, in the “Mid Third Century Imperial”, when “Aditya had come up for annexation”,⁹⁶ the Galactic Empire doesn’t negotiate, it “simply informed the planetary government that” “This planet is now under the rule of his Imperial Majesty, Rodrick III. If this Mastership wants to govern the planet under the Emperor, they may do so. If not, we will make an end of them and set up a new government here.”⁹⁷ And, “We’d better make the limits of your sovereignty the orbit of the outer planet of this system. You may have your own normal-space ships, but the Empire will control all hyperdrive craft, and all nuclear weapons.”⁹⁸

The postulated Lakshmanian Confederation will therefore exist as an independent association for only about a quarter century (c. AE 1791-1818), and as a subordinate association under the Mardukan Empire for another thirty years (c. AE 1818-1848) before its dissolution.

But the parallels need not be exact. It might make more sense for the Lakshmanian Confederation to arise earlier in time, perhaps a couple of centuries. This would allow it to gradually develop and expand until its borders reach those of the similarly-expanding greater powers. But even absorption by Marduk early in its history may not signal its demise. Given the long-range mission of the Lakshmanian Artisans, the Endless Association may arise in some form again; after the Galactic Empire itself disintegrates, more than a millenium later.⁹⁹

As for the fortified burrow-cities of Lakshmi, and their interconnecting tunnel system, these would be a magnified future parallel of the underground military facilities of Switzerland, and the road and rail tunnels under the Alps. “Swiss building codes require radiation and blast shelters to protect against bombing. Such shelters are said to be able to accommodate 114% of the Swiss population. There are also hospitals and command centers in such shelters, aimed at keeping the country running in case of emergencies ...Moreover, tunnels and key bridges are built with tank traps. Tunnels are also primed with demolition charges to be used against invading forces. Permanent fortifications are established in the Alps, as bases from which to retake the fertile valleys after a potential invasion. They include underground air bases which are adjacent to normal runways; the aircraft, crew and supporting material are housed in the caverns.”¹⁰⁰

Overall, the Tectonicon of Lakshmi is a combination of the Freemasons and Switzerland, medieval and present. A creative combination is desirable, since that is the method Piper appears to have used himself. As we have seen, the Terran Federation is a combination of the British and Roman Empires. From my other researches, I can add that the Freyans combine the Boers with Trojan refugees, and the Space Vikings themselves combine historical Vikings and Seventeenth Century pirates.¹⁰¹

c) An Old Science-Fiction Concept

The topic of this paper, underground or ‘burrow’ cities, appears to be an old concept in science fiction. In fact, *The Underground City* by Jules Verne (also called *The Child of the Cavern*; 1877) may have originated the idea in this genre. The plot of *The Underground City* “follows the fortunes of the mining community of Aberfoyle near Stirling, Scotland. Receiving a letter from an old colleague, mining engineer James Starr sets off for the old Aberfoyle mine, thought to have been mined out ten years earlier. Starr finds mine overman Simon Ford and his family living in a cottage deep inside the mine; he is astonished to find that Ford has made a discovery of the presence of a large vein of coal...Soon after the discovery of the new vein of coal, the community is revitalised with a whole town growing up around the underground lake called Loch Malcolm.”¹⁰²

Another example is found in *The Time Machine* (1895), set in a far-future age where an evolved subset of humanity, the Morlocks, dwells underground. Or perhaps devolved, for the Morlocks are “ape-like troglodytes who dwell in darkness underground and surface only at night. Within their dwellings [the Time Traveler] discovers the machinery and industry that makes the above-ground [Eloi] paradise possible. He alters his theory, speculating that the human race has evolved into two species: the leisured classes have become the ineffectual Eloi, and the downtrodden working classes have become the brutish light-fearing Morlocks.”¹⁰³

But it was the advent of aerial warfare in WWI, with its imperative for taking shelter to avoid bombing, that gave the concept its modern meaning. After the war, one version of the underground cities projected for the near future appeared in the March, 1924 issue of *Science and Invention* magazine. (Figure 11.) The caption under the title reads,

From cave man back to cave man seems to be the trend of civilization. At least, that will be the trend if warfare continues. Below is depicted the city of the future built completely underground for the sake of safety from enemy aircraft. Note the way all outlets are camouflaged. The arrangements for carrying the sun's rays underground and the method of using waterpower and radio is ingenious. Everything will be consolidated and grouped so as to put each inch of room to the greatest possible advantage. Crops will be raised underground. Several of them will be taken from the same piece of soil yearly by the art of electrically forcing the growth of the plants. Even the protective armament for the city will be electrical.¹⁰⁴

Several elements of this early 1920s concept appear in *The Cosmic Computer*, published almost forty years later, in 1963. The first is camouflaged outlets, or entrances. On Poictesme, the shafts into Force Command Duplicate are camouflaged, partly from natural causes. "They built a shaft a hundred feet in diameter like a chimney at one side, and they ran a tunnel out through solid rock to the head of a canyon half a mile away. Then they buried the whole thing... For a month each winter, cold rains from the east lashed the desert; for the rest of the year, it was swept by windblown sand. Wiregrass sprouted, and thorn bush grew; Nature, the master-camoufleur, completed the work of hiding the forgotten head-quarters."¹⁰⁵

The second is buried communications. At the center bottom of Figure 11, notice the underground "BROADCASTING STATION FOR ENTERTAINING AND FOR GUIDING RADIO CONTROLLED TORPEDOES". Force Command Duplicate contains something similar. "The gang on the mesa-top had discovered something else; a grid of aurocopper bussbars buried four feet underground. Ten to one, radio and telescreen signals would be transmitted to that from below, and then probably picked up and rebroadcast from a relay station on one or another of the high buttes in the neighborhood."¹⁰⁶ This is quickly located. "The next day they found the relay station which rebroadcast signals from the buried aerial—or wouldn't one say, subterrial?—on top of the mesa. As Conn had expected, it was on top of a high butte three and a half miles to the south; it had been so skillfully camouflaged that none of the outlaw bands who roamed the Badlands had found it. After that, Force Command Duplicate was in communication with the rest of Poictesme."¹⁰⁷

And third is the use of an extinct volcano. The upper left of the *Science and Invention* illustration shows that "SMOKE AND POISON GAS FROM FACTORIES COMES OUT OF MOUNTAIN, MAKING IT LOOK LIKE VOLCANIC ACTION CONFUSING ENEMY". Moreover, the top tier of the burrow-city's defense system includes "AUTOMATIC LONG RANGE DISAPPEARING GUNS", run by electricity, plus an underground aerodrome, where biplanes and zeppelins are kept in readiness for launch against enemy air forces. Piper appears to have combined all of these elements, plus the battle depicted in the sky—and even the illustration's black and white colors—into Barathrum Spaceport. The spaceport was built "inside the crater of an extinct volcano"¹⁰⁸ on the island of Barathrum, and "Barathrum was a grim land, naked black and grey."¹⁰⁹ As the squadron from Force Command Duplicate approaches the volcano, they are fired upon. "When they were within five miles of it, something twinkled slightly near the summit. An instant later, the missileman, in his turret overhead, shouted: "Missile coming up; counter-missile off!" "¹¹⁰ But missiles are only the beginning of Barathrum's defenses. "Guns were firing from the mountaintop, too, big ones, and shells were bursting close to them. He saw a shell land on and another beside one of the enemy gun positions—115-mm's from the *Lester Dawes*, he supposed."¹¹¹ Conn's plans and photomaps of the spaceport show that the volcano's crater 'was ringed, outside, with [missile] launching sites and gun positions, and...some of the guns were as big as 250-mm."¹¹²

In addition, Piper mentions that "ship docks and shops were down on the level of the crater floor, in caverns, both natural and excavated, that extended far back into the mountain."¹¹³ These seem to parallel the zeppelin hangars and "aerodrome factory" in Figure 11, where the burrow-city's air force is housed. We could also add the "pillar-buildings" in *Four-Day Planet*, that are "square buildings, two hundred yards apart, which rest on foundations on the Bottom Level and extend up to support the roof" of Port Sandor.¹¹⁴ These seem to combine the "VENTILATORS IN EVERY SUPPORT" with the "PACKING HOUSE FOOD PRODUCTS AND CANNING FACTORY" seen in the *Science and Invention* illustration.

Underground Cities

From cave man back to cave man seems to be the trend of civilization. At least, that will be the trend if warfare continues. Below is depicted the city of the future built completely underground for the sake of safety from enemy aircraft. Note the way all outlets are camouflaged. The arrangements for carrying the sun's rays underground and the method of using waterpower and radio is ingenious. Everything will be consolidated underground and the method of using waterpower and radio is ingenious. Everything will be consolidated underground and the method of using waterpower and radio is ingenious. Crops will be raised underground. Several of them will be taken from the same piece of soil yearly by the art of electrically forcing the growth of the plants. Even the protective armament for the city will be electrical.

—Suggested by Lyman Mason.

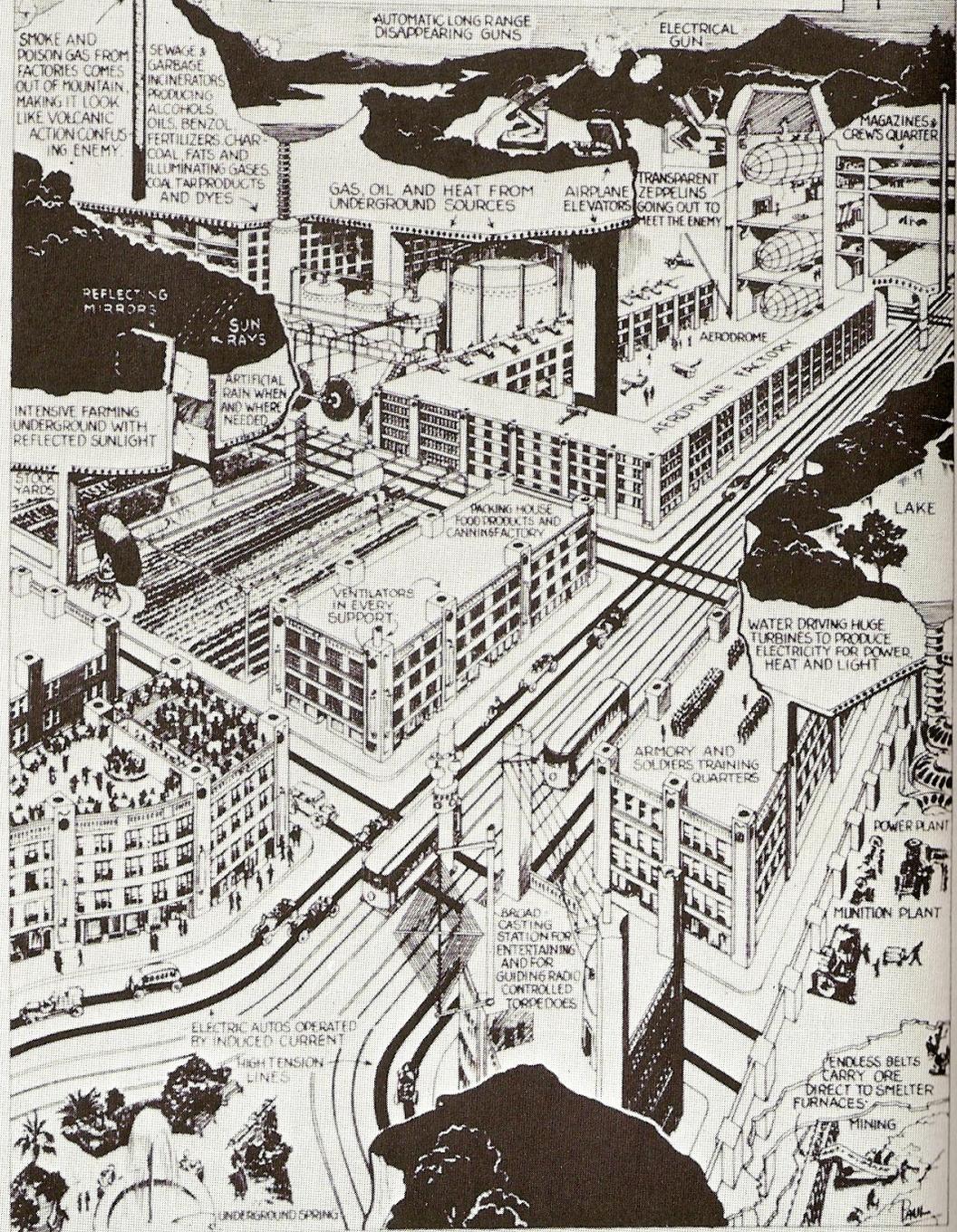


Figure 11. An underground city concept, from *Science and Invention* magazine, March 1924. ¹¹⁵

The major difference is in the power source. Piper's burrow-cities like Port Sandor, and hidden spaceports like Barathrum, are nuclear-powered, rather than with electricity derived from water, solar or geothermal sources. Another big difference is in the weaponry; quite a few nukes are detonated in the Battle of Barathrum,¹¹⁶ and the hangars of Beam's burrow-cities certainly do not contain biplanes or "transparent zeppelins"!

Thus, later versions of the 1924 underground city concept may well have appeared in the science and technology magazines, which could have come to Piper's attention. And there are certainly plenty of other examples of underground cities in science-fiction, from the early Twentieth Century into the 1950s. A couple from Piper's time include the following. "SF Pariah Elites may construct underground City refuges, as in A.E. Van Vogt's *Slan* (September-December 1940 Astounding; **1946**; rev. **1953**) [and] Henry Kuttner's *Mutant* (stories February 1945-September 1953 Astounding; fixup **1953**)."¹¹⁷ Also, Trantor, the capital of Isaac Asimov's First Galactic Empire, could possibly be considered a burrow-world. This is because, although the city is perfectly visible from the air and space, it is mostly underground. "Trantor is tunneled over a mile down. It's like an iceberg. Nine-tenths of it is out of sight. In fact, we're down so low that we can make use of the temperature difference between ground level and a couple of miles under to supply us with all the energy we need."¹¹⁸

Hopefully, the present paper has expanded on the burrow-city idea in a way that Piper would have approved. Beam himself referenced the science-fiction of his era. One example is the 1951 movie "The Thing (From Another World)". From the polar ice cap, a human expedition releases an alien being that has the potential to wipe out (or in the original story, take over) all life on Earth. This idea appears in *The Cosmic Computer*, as a jury-rigged combination of collapsium-cutter and spaceship. Dubbed *The Thing* by its creators, this unique and monstrous assemblage is flown from Koshchei to Poictesme, and is therefore also 'from another world'.¹¹⁹ *The Thing* is used by the humans in the story to unseal Merlin, a computer attributed by some with a malevolent sapience, which is variously feared will either take over or destroy the planet. "Merlin had been found...Merlin was being transported to Storisende to be installed as arbiter of the Government. Merlin the Monster was destroying the planet."¹²⁰ In fact, Merlin almost does destroy Poictesme, though indirectly, when the chaos inspired by his opening causes the people on Koshchei to threaten the planet with nuclear annihilation.¹²¹

And in *Space Viking*, Beam referenced "The Day the Earth Stood Still" (also 1951). "Mardukan robots...looked like surrealist conceptions of Pre-Atomic armored knights".¹²² These are obviously modeled on Gort, a silvery giant robot whose knightly visor conceals a powerful disintegration beam.

In order to make their stories as Piper-like as possible, writers in his universe would therefore be well advised to incorporate a few inside references to old tales, and concepts, from the Golden Age of science fiction.¹²³ Given the caliber of the authors in those days—Isaac Asimov, Robert Heinlein, Arthur C. Clarke, L. Sprague de Camp, E. E. "Doc" Smith, Ted Sturgeon, and so on¹²⁴—this could only be a good thing.

ENDNOTES

1. Introduction

1. John F. Carr and Mike Robertson, *The Last Space Viking* (Boalsburg, PA: Pequod Press, 2011), p. 16
2. H. Beam Piper, *Space Viking* (New York, NY: Ace Books, 1963), pp. 79, 10 The futile resistance of the Kheperans causes Lucas Trask to ask Otto Harkaman what he would do in their place. He replies, "Fight. Try to kill as many Space Vikings as I could until they got me. Terro-Humans are all stupid like that. That's why we're human." The emigration of the Alliance refugees is described earlier in the book. "Ten thousand men and women on Abigor, refusing to surrender, had taken the remnant of the System States Alliance navy to space, seeking a world the Federation had never heard of and wouldn't find for a long time. That had been the world they had called Excalibur. From it, their grandchildren had colonized Joyeuse and Durendal and Flamberge; Haulteclere had been colonized in the next generation from Joyeuse, and Gram from Haulteclere."
3. H. Beam Piper, *Fuzzies and Other People* (New York, NY: Ace Books, 1984), p. 1 I do not capitalize burrow-worlds, because unlike the Sword-Worlds, they are not a cohesive group of planets colonized from a single source. They therefore do not share a common history and culture, and moreover are scattered around the Old Federation. For the even smaller group of worlds whose inhabitants retreat into their oceans and build underwater dome-cities, see my companion piece "Of Mer-Worlds".

2. Burrow-Worlds

4. H. Beam Piper, *Four-Day Planet/Lone Star Planet* (New York, NY: Ace Books, 1961), p. 31
5. *Ibid.*, pp. 31-32
6. *Ibid.*, p. 76
7. The Third World War is fought between the northern nations of the Terran Federation, led by the United States, and the Eastern Axis, led by the Soviet Union. The Fourth World War is again fought between the northern nations of the Terran Federation (still led by the United States), this time against what I call the Sino-Hindic Axis; an Asian alliance led by Red China, now a superpower. That Red China is the main enemy is supported by the historical model; see my paper "Piper's WWIV—From War of Spanish Succession to War of Indian Election". Walter Boyd specifies that the burrow-cities were built in the Northern Hemisphere of Terra, and in *Uller Uprising*, Carlos von Schlichten confirms that "the Southern Hemisphere managed to stay out of the Third and Fourth World Wars." (H. Beam Piper, *Uller Uprising* (New York, NY: Ace Books, 1983), p. 55) Thus, it would seem that no burrow-cities were ever built south of the equator. This probably works to Terra's disadvantage when the Interstellar Wars begin. A lack of underground facilities will undoubtedly make it easier for the capital planet of the Federation, whose major cities are now concentrated in the Southern Hemisphere, to be "*bombed back to the Stone Age in one of the many wars that followed the Federation breakup*". (John F. Carr, Introduction to "The Return", *Empire* (New York, NY: Ace Books, 1981), p. 181)
8. Piper, *Space Viking*, p. 137
9. Piper, *Uller Uprising*, p. 150 The first Bethe-cycle bombs may have been smaller and less powerful than the hellburners in *Space Viking*. But even a fusion reaction with a destructive radius of only 100 or 200 miles would require just a few tens of bombs to wipe out a major Terran nation. Contrast that number with the literally thousands of nuclear weapons the US and USSR once had aimed at each other, even granting that these were enough to destroy the world many times over.
10. Piper, *Four-Day/Lone Star*, p. 31
11. Still from the 1936 movie "Things to Come"; <http://www.625.org.uk/ttc/index.htm> Since it is an underground city, and "Things to Come" is set in 2036, Everytown would actually fit into Piper's description of the burrow-cities built during the Atomic Wars waged in the First and Second Centuries of the Atomic Era. (What wouldn't fit are Wells' unified world setting, and probably the clothing of Everytown's population.) The year 2036 is well after Beam's WWII, which occurs in 1974, and just over a decade before his WWIV begins, in 2049. Moreover, the Everytown of H.G. Wells was similarly built after a period of barbarism following a decades-long Second World War, which

devastates the world. (http://www.sfencyclopedia.com/entry/things_to_come)

Wells may not be the best example to use in a paper about Piper's universe, however, since Beam was not overly fond of his brand of science fiction. He said that "I never wanted to write like H.G. Wells, he spent entirely too much of his time on a soapbox." (John F. Carr, *H. Beam Piper: A Biography*, (Jefferson, North Carolina: McFarland & Company, Inc., 2008), p. 79) Piper wasn't the only one to notice. An online description of the movie "Things to Come" says that "Characterization and dialogue are weakly imagined and the rhetoric is preachy and pompous, despite the famously overblown but moving concluding speech delivered by Raymond Massey, as he declares of Man: "...and when he has conquered all the deeps of space and all the mysteries of time, still he will be beginning." (http://www.sf-encyclopedia.com/entry/things_to_come)

12. Piper, *Four-Day/Lone Star*, p. 33

13. Piper, *Space Viking*, p. 102

14. Piper, *Uller Uprising*, p. 164

15. H. Beam Piper, *The Cosmic Computer* (New York, NY: Ace Books, 1963), p. 11

16. Of the other celestial bodies possessing burrow-cities mentioned by Piper, Luna and Titan are moons, and so probably cannot be classed as burrow-worlds. While Mercury is a planet, it is only about the size of Callisto, and smaller than Ganymede, two moons of Jupiter. Moreover, its burrow-cities are only located in the Twilight Zone. That would seem to exclude Mercury as well, unless its slender civilization somehow survives the Interstellar Wars.

17. Piper, *Four-Day/Lone Star*, pp. 6, 30, 48 The end of the Fourth Century should be about 399 AE. Port Sandor "was built close to a hundred years ago"; that's after the first conventional surface city was found to be uninhabitable "after one day-and-night cycle", or around 400 AE. (*ibid.*, p. 31) Close to a hundred years later should therefore place the time of *Four-Day Planet* at about 498 AE. That's the end of the Fifth Century. But in "The Future History", Beam approximates the novel as occurring in the "Mid-IV Century" (Carr, *Piper Biography*, p. 213).

Uller Uprising occurs in AE 526, and in that novel Piper mentions that nuclear weapons have been used on Fenris. (Piper, *Uller Uprising*, p. 138) This appears to mean that "Civil War Postponed", one of the chapters of *Four-Day Planet*, is literally correct. Sometime between 498 and 526 AE, a civil war on Fenris does indeed occur, and nuclear weapons are detonated; possibly by the combatants, but more likely by the Terran Federation. Depending on how much damage is inflicted, Fenris may therefore not be the first burrow-world after all. However, at the very least it would be a forerunner, and Fenris' civil war is overshadowed by a greater one on one of its conceptual descendants. (See section, A Civil War Burrow-World.)

Incidentally, a postponed civil war on Fenris is perfectly in accord with one of Beam's main themes. As stated by John Carr, "In each of these stories we have Piper's self-reliant man...versus the tide of history. At the end of each of these stories it appears as though the self-reliant man has won; however in future stories we learn that while the battle may have been won, the war was lost." (John F. Carr, Introduction to *Empire*, p. 9) At the end of *Four-Day Planet*, a civil war is averted, "the hunters got an honest co-operative and Fenris got an honest government, and Bish Ware got Anton Gerrit the slaver" (Piper, *Four-Day/Lone Star*, p. 216). Despite this happy ending, however, and "because of the deterministic forces of history" (Carr, *Empire* Introduction, p. 9), it appears that the future of Fenris includes a return of corruption, racketeering and civil war, not averted this time.

18. Piper, *Four-Day/Lone Star*, p. 6

19. Piper, *Cosmic Computer*, p. 47

20. *Ibid.*, pp. 68, 95

21. *Ibid.*, p. 60

22. Joseph J. Corn and Brian Horrigan, *Yesterday's Tomorrows* (Baltimore, MD: The Johns Hopkins University Press, 1984), p. 106

23. *Ibid.*

24. Another detail Beam never mentions is whether a conragravity field can pass safely through solid matter without disturbing it. "Built to operate only inside planetary atmosphere and gravitation, the *Harriet Barne* was long and narrow, like an old ocean ship; more than anything else, she had originally resembled a huge submarine." (Piper,

Cosmic Computer, p. 124) The *Harriet Barne*, and air ships like her, fly by contragravity. Assuming the field is spherical, then when such a ship takes off or lands, its contragravity field will intersect with the ground below, not to mention the structure it is docking to. So there should be some sort of interaction. For example, a piece of debris on the ground—or even a person—could be outside the ship but within the field, and be carried aloft when the ship takes off!

But I may be wrong, and contragravity fields are not spherical. Or if they are spherical, perhaps they don't have to enclose the whole vehicle. It may only be the contragravity generator that takes off, and since the vehicle's structure is physically attached, it simply goes along. Another possibility is that Piper himself did not think through the actual mechanics of contragravity fields, simply employing them as a useful device to illustrate the futuristic settings of his stories. After all, in those days everyone assumed that we would soon be flying everywhere, instead of driving.

25. Piper, *Space Viking*, p. 78; *Cosmic Computer*, p. 105; and H. Beam Piper, *Little Fuzzy* (New York, NY: Ace Books, 1962), p. 12 The postulated invention of a contragravity train would be ironic, because Piper states that the invention of contragravity itself made trains obsolete. In *Uller Uprising*, Eric Blount says that "When we came to Uller, we found a culture roughly like that of Europe during the Seventh Century Pre-Atomic, or, more closely, like that of Japan before the beginning of the First Century P.A. We initiated a technological and economic revolution here, and such revolutions have their casualties, too. A number of classes and groups got squeezed pretty badly, like the horse-breeders and harness-manufacturers on Terra by the invention of the automobile, or the coal and hydroelectric interests when direct conversion of nuclear energy to electric current was developed, or the railroads and steamship lines at the time of the discovery of the contragravity-field." (Piper, *Uller Uprising*, pp. 49-50, emphasis added)

26. Piper, *Four-Day/Lone Star*, p. 77

27. Piper, *Cosmic Computer*, p. 124

28. http://en.wikipedia.org/wiki/Yves_Rossy

29. Ben R. Rich and Leo Janos, *Skunk Works* (Boston, MA: Little, Brown and Company., 1994), p. 139

As Ben continues the story, "One Sunday I went over to his house and we lit the powder charge on the front lawn. Boom! The square projectile shot in a high arc across the street and blasted through the neighbor's upstairs window. "Wow," Dave grinned. "That little sucker really works!" " (ibid.)

Owning his own 'eensy' brass cannon, H. Beam Piper would have certainly liked the little square cannon. He might have even challenged Robertson to a battle.

30. H. Beam Piper, *Federation* (New York, NY: Ace Books, 1981), p. 19

33. Jules Verne, *From the Earth to the Moon* (Philadelphia, PA: David McKay, publisher, c. 1900), p. 277

The moon-train engraving is based on a speech by Michel Ardan, the Frenchman who comes to America and joins the moon-shot project. Denying that the distance to the Moon should be any obstacle to a voyage there, he says that "Distance is only a relative term...In what time, let me ask you, would an express train, running little more than thirty miles an hour, reach the Moon? Three hundred days. No more. Not even nine times a trip round the world. Few travelers or sailors worthy of the name, have not gone much further in their day. Consider now that, once started, I shall be only 97 hours on the road!" (ibid., p. 273)

The postulated invention of a normal-space moon-train could occur during the Surromanticist period (c. 600 AE), if in addition to Cabell, Spenser and Rabelais, it includes the rediscovery of Jules Verne. However, the characters in Verne's book begin their project to build a space cannon and fire a manned projectile to the Moon right after the US Civil War, in the later 1860s. (ibid., p. 23) Thus, since the Civil War is the historical model for Piper's System States War, the postulated Luna Express could instead be built soon after the System States Alliance is defeated, in AE 854. If so, then the eccentric genius who builds it could have gotten rich during the War, possibly even on Poictesme. For when the war ended, "The Federation armies departed... [and] The people who had grown richest out of the War had followed, taking their riches with them." (Piper, *Cosmic Computer*, p. 5)

They apparently take their riches to Terra, because the commander of the Federation armies on Poictesme is General Foxx Travis, who retires to Luna. (ibid., p. 20) Thus, at least some of the war-wealthy who abandon the Trisystem return to the Solar System, among whom could be our postulated eccentric. This brings us to a very interesting possibility. If the Luna Express he invents is still running forty years after the War, one of its passengers could actually be Conn Maxwell, who visits General Travis on Luna before he returns to Poictesme!

31. Piper, *Four-Day/Lone Star*, p. 94

32. Piper, *Space Viking*, p. 41

34. Piper, *Cosmic Computer*, p. 129

35. After writing this section, I happened to watch "The Day the Earth Stood Still" on DVD. At one point in the movie, Klaatu borrows Bobby Benson's flashlight. Bobby is playing with a toy train set on the floor of his room, about which Klaatu remarks, "I must tell you sometime about another kind of train. A kind that doesn't need any tracks." (The line does not appear in the Final Revised Draft of the screenplay, dated February 21, 1951, though it should be on page 77. It must have been added later; perhaps during filming.)

Klaatu's people must have therefore developed contragravity, which is certainly suggested by the way his inter-planetary flying saucer lands and takes off. But his statement about not needing any tracks means that contragravity trains are in fact among their *planetary* transport systems.

36. Piper, *Space Viking*, p. 82

37. *Ibid.*, pp. 235-240

38. *Ibid.*, p. 120

3. A Civil War Burrow-World

39. Piper, *Four-Day/Lone Star*, p. 268

40. Piper, *Space Viking*, pp. 88, 90

41. *Ibid.*, pp. 162-3

42. Piper, *Little Fuzzy*, p. 6

43. The postulated aqueduct tunnels and cisterns of the burrow-cities have a precedent on Beam's Mars. In the story "Omnilingual", it is said that "There was the work of getting the city's [Kukan's] ancient reservoirs cleared of silt before the next spring thaw brought more water down the underground aqueducts [sic] everybody called canals in mistranslation of Schiaparelli's Italian word" (Piper, *Federation*, pp. 35-36). In "Beam's Mars Revealed", I stated that the traditional view of the Martian canals had them open to the sky and ground for hundreds if not thousands of miles. This is not a very efficient system, if water is that precious.

Thus, Piper's idea to place the Martian aqueducts underground was smart engineering, as it would minimize evaporation losses to the atmosphere. And being underground, they would of necessity be enclosed, probably by pipes. This would minimize seepage losses into the surrounding soil. Underground pipes would also keep the water from freezing or boiling, in the wide swings of Martian surface temperature, as it flows from the icecaps to cities at lower latitudes, as far as the equator. These advantages would make for a much more efficient hydrologic system.

(However, Beam's underground Martian aqueduct system may actually be modeled on that of Edgar Rice Burroughs. See "Beam's Mars Revealed", Appendix 3.)

44. <http://my.opera.com/nielsol/blog/?tag=volcanoes&startid=30&nodaylimit=1>

I modified the original image by increasing the width on either side.

45. Piper, *Space Viking*, p. 146

46. Piper, *Uller Uprising*, pp. 4-6

47. *Ibid.*, p. 8

48. *Ibid.*, p. 9 This may yet prove true, as the idea of using nuclear weapons for peaceful purposes was abandoned in the late 1970s, before any actual project was authorized, much less completed. The proof of concept effort for peaceful nukes was known as Project Plowshare. "**Project Plowshare** was the overall United States term for the development of techniques to use nuclear explosives for peaceful construction purposes... Proposed uses included widening the Panama Canal, constructing a new sea-level waterway through Nicaragua nicknamed the Pan-Atomic Canal, cutting paths through mountainous areas for highways, and connecting inland river systems. Other proposals involved blasting underground caverns for water, natural gas, and petroleum storage. Serious consideration was also given to using these explosives for various mining operations."

(http://en.wikipedia.org/wiki/Operation_Plowshare)

Though I have not been able to confirm it, my feeling is that a proposal for using atomic bombs for mining was first proposed in the late 1940s, before Piper wrote *Uller Uprising*. Perhaps an article in the newspaper, or the science and technology magazines of the time, such as *Scientific American* or *Popular Mechanics*. Beam appears to have been inspired by other such articles; see section “All Conceivable Levels of Complexity and Technology”, as well as my paper “Piper’s Clippings”.

49. Piper, *Little Fuzzy*, p. 5

50. <https://secure.wikimedia.org/wikipedia/en/wiki/Supervolcano>

51. http://en.wikipedia.org/wiki/Long_Valley_Caldera

4. A Strip Mine Burrow-World

52. Piper, *Four-Day/Lone Star*, p. 40

53. Piper, *Federation*, p. 189

54. Piper, *Cosmic Computer*, pp. 24-25

55. As a humorous aside, it occurs to me that if the US-led First Terran Federation had moved completely underground, rather than just building some burrow-cities, the resulting tectonic civilization could be called the ‘United Plates’ of Terra.

56. Didn’t even have to move and look this up. Learned it from my laptop’s built-in dictionary!

57. See my paper, “The Lakshman System”.

58. A similar trust-busting situation may occur on Poictesme, after the time of *The Cosmic Computer*. In that novel, the creation of a myriad of new companies, all owned and run by the same small group of people, causes Rodney Maxwell to state that “Sterber, Flynn and Chen-Wong will probably be defending [us against] antitrust suits till the end of time.” (Piper, *Cosmic Computer*, p. 184) Though unstated by Beam, this may be a foreshadowing of a legally-sanctioned breakup that signals the end of Poictesme’s new age of prosperity. And an economic downturn or collapse could help explain why Poictesme fails to create a new universal state, contrary to the expectations at the end of the novel. As Conn Maxwell puts it, “If that means blowing up the Federation, let it blow. We’ll start a new one here.” (ibid., p. 243)

59. Piper, *Uller Uprising*, p. 15

60. Piper, *Federation*, p. 25

61. http://en.wikipedia.org/wiki/Easter_Island

62. http://en.wikipedia.org/wiki/Great_Wall_of_China

63. <http://www.mastermason.com/bridgeportlodge181/MASHST05.HTM> In his book, *The Sign and the Seal*, Graham Hancock attributes the Gothic style of architecture to the Knights Templar, who may have brought lost knowledge back from the Holy Land. (Graham Hancock, *The Sign and the Seal* (New York, NY: Simon & Schuster, Inc., 1992), pp. 101-102) Hancock therefore connects the Templars with the Freemasons, as other writers such as John J. Robinson have done. (See endnote 101, below.)

64. <http://en.wikipedia.org/wiki/Freemasons>

65. The Masonic reference to their trade as ‘the Craft’ would then be paralleled by the Artisans referring to their combined trades as ‘the Crafts’, or perhaps better, ‘the Pan-Craft’. Given the Artisans’ outer space and futuristic setting, I was briefly tempted to call it ‘the Space-Craft’.

A spacecraft may in fact be relevant. Masons have many symbols, one of the most important of which is something that was allegedly built by them. This is the Unfinished Temple of Solomon, which may be the source for the topless pyramid seen on the reverse of the Great Seal of the United States.

For this reason, one of Piper's spherical space ships is among the Artisans' symbols. But one still under construction; an 'unfinished' space ship, such as the one on Koshchei which Conn Maxwell notices is missing "a hundred-foot circle [of collapsium] at the top". (Piper, *Cosmic Computer*, p. 147) The Unfinished Spaceship symbol of the Artisans would have several meanings. Not only would it represent the Lakshmians' loss of hyperdrive and efforts to reacquire it, but also their uncompleted yet ongoing universal mission of exploration and discovery. This would include the fact that the vast majority of the Galaxy has yet to be explored, and by extension the Unfinished Universe itself. (Again, see "The Lakshmi System".)

66. Karl Jung used the term 'archetype' to describe the archaic or primordial contents of the collective unconscious; "images that have existed since the remotest times". In the First Century CE, the Alexandrian philosopher Philo Judaeus defined archetype as "the God image in man". (Immanuel Velikovsky, *Mankind in Amnesia* (Garden City, NY: Doubleday & Co., 1982), p. 20) The Lakshmi Archetypes can therefore be defined as 'man's image of the Gods that have existed since primordial times'.

67. A few obvious possibilities include imaginative examples from human history. One could be a universe in which magic is the rule of nature. Another might be geocentric, in which a habitable planet is at the center of the universe, and the stars are affixed to a rotating spherical shell around it. A third could combine the theories of Cyrus Teed and Freeman Dyson, being a universe in which stars are at the center of planets, and people live on the inside rather than outside of these worlds. David J. Lake's 1982 novel, *The Ring of Truth*, was based on Teed's conception.

68. Piper, *Cosmic Computer*, p. 188, emphasis added

69. Carr, *Piper Biography*, p. 11

70. Piper, *Space Viking*, p. 112

71. Ibid.

72. Ibid., pp. 32-33 Otto Harkaman says to Lucas Trask that "The Old Federation, where you're going to hunt Dunnan, occupies a space-volume of two hundred billion cubic lightyears. And you're hunting for one ship and one man in that. How are you going to do it, Lord Trask?...We'll hear where he was a year ago, and by the time we get there, he'll be gone for a year and a half to two years. We've been raiding the Old Federation for over three hundred years...[and] At present, I'd say there are at least two hundred Space Viking ships in operation. Why haven't we raided it bare long ago? Well, that's the answer: distance and voyage-time."

Though it takes many years, much expense, and not a little bloodshed, Trask finally does catch up to and kill Dunnan. Thus, if our postulated Gilgameshers went after a Space Viking crew that had stolen one of their ships, they would face the same extreme difficulties. So another tactic they could try is one also suggested by Harkaman; "The only way we can catch [Dunnan] is by interception. The longer he moves around in the Old Federation before he hears we're after him, the more of a trail he'll leave. Once we can establish a predictable pattern, we'll have a chance. Then, some time, he'll come out of hyperspace somewhere and find us waiting for him." (ibid., p. 34) The Gilgameshers could similarly bide their time, or even bait a trap, hoping the offending Vikings will come to them.

73. Piper, *Space Viking*, p. 64

74. The Gilgameshers may not have done it all on their own, either. Piper says that "Perhaps Gilgamesh deserved more credit; its people had undergone two centuries of darkness and pulled themselves out of it by their bootstraps. They had recovered all the old techniques, up to and including the hyperdrive." (Piper, *Space Viking*, p. 112)

Notice the indefinite 'perhaps'. Perhaps Gilgamesh deserves more credit, *but perhaps it doesn't*. If the cosmic computer Merlin is on Gilgamesh, then Merlin is in fact the Gilgamesher deity, "Yah the Almighty". (ibid., p. 113) The Merlin-Yah connection is supported by the fact that Merlin is described as a robot god. "And if you'd asked such a computer, "Is there a God?" it would have simply answered, "Present"." (Piper, *Cosmic Computer*, p. 16) It is a salient fact that Merlin's "memory-bank contained all human knowledge" (ibid.); this knowledge would obviously include the theory and practice of hyperspatial travel.

Thus, it is quite possible that Merlin the Cosmic Computer-God, a.k.a. Yah the Almighty, helped the Gilgameshers recivilize. That could explain why it only took two centuries, when by the time of *Space Viking*, the vast majority of the Old Federation is still barbarous.

5. "All Conceivable Levels of Complexity and Technology"

75. This is to keep my creation subordinate to Piper's. The burrow-worlds would then contain fewer planets than the

Sword-Worlds. I keep the term lower case because while the Sword-Worlds are a closely related group of planets sharing a common culture, and whose offspring the Space Vikings play a major role in the Future History, the burrow-worlds are scattered across the Old Federation, possess widely different cultures, and due to their defensive nature probably make little contribution to Terro-Human history, save for the Tectonicon of Lakshmi.

76. Carr, *Piper Biography*, p. 176

77. Piper, *Space Viking*, p. 220 In their book, John Carr and Mike Robertson convert the Abaddon base into a jail for Mardukan prisoners of state. (Carr and Robertson, *The Last Space Viking*, p. 72) An intriguingly appropriate idea, although they incorrectly refer to Abaddon as a "moon".

78. The purpose of the chart is to show the historical parallels; the actual timelines do not line up quite so neatly. Independent Rome actually lasted from about 506 BC to 476 AD, while the Terran Federation spans from AE 31 to about 1097. So the offset is more like 550 years, rather than an even 500. The 1654 date of *Space Viking* would then become AE 1704, which agrees with Piper's approximation in "The Future History". "SPACE VIKING -- Early XVIII Century". (Carr, *Piper Biography*, p. 213)

79. <http://en.wikipedia.org/wiki/Switzerland> The Endless League reference comes from H.G. Wells, *The Outline of History* (Garden City, NY: Garden City Books), 1949, p. 791

80. Again, see "The Lakshmanian System".

81. <http://en.wikipedia.org/wiki/Switzerland>

82. Ibid., and http://en.wikipedia.org/wiki/History_of_Switzerland; and Wells, *Outline of History*, p. 790

83. Piper, *Space Viking*, pp. 115-116 Of Andray Dunnan's interstellar activities, Otto Harkaman says that "He got the furs on Imhotep; he traded for them...Nobody gets anything off Imhotep by raiding. The planet's in the middle of a glaciation, the land surface down to the fiftieth parallel is iced over solid. There is one city, ten or fifteen thousand, and the rest of the population is scattered around in settlements of a couple of hundred all along the face of the glaciers...They use telescope sights, and everybody over ten years old can hit a man in the head at five hundred yards. And big weapons are no good; they're too well dispersed. So the only way to get anything out of them is to trade for it."

84. <http://en.wikipedia.org/wiki/Switzerland>

85. http://en.wikipedia.org/wiki/History_of_Switzerland

86. http://en.wikipedia.org/wiki/History_of_Switzerland

87. <http://en.wikipedia.org/wiki/Switzerland>

88. http://www.lib.utexas.edu/maps/historical/central_europe_1460.jpg

89. H. Beam Piper, *Empire* (New York, NY: Ace Books, 1981), p. 78

90. Ibid., p. 87

91. Ibid.

92. Piper, *Space Viking*, p. 233

93. Piper, *Empire*, p. 89

94. According to the timeline in *Empire*, AE 1848 is when "King Steven [sic] IV becomes the first Galactic Emperor". This implies the Empire is proclaimed in that year, most likely with the adoption of the Imperial Constitution, or at least concurrent with it.

95. Piper, *Empire*, p. 89 See "The Emblem of the Galactic Empire" for a discussion of the Imperial political system.

96. Carr, *Piper Biography*, p. 214; and Piper, *Empire*, p. 74

97. Piper, *Empire*, pp. 73, 77

98. *Ibid.*, p 88

99. The timeline in *Empire* says “2936 Paul XXII tries to move the Empire out of its complacent rut.” Although it certainly leads to a brief renewal of vitality, Paul’s attempt appears to also trigger the start of an irreversible breakup. John Carr says that “despite Paul the Twenty-Second’s Ministry of Disturbance, the Empire is destined to fall. Paul’s plans to save the Empire—like those of Conn Maxwell in *The Cosmic Computer* and Lucas Trask in *Space Viking*—are destined to fail because of the deterministic forces of history.” (Carr, Introduction to *Empire*, p. 9)

Since Paul’s attempt to renew the Empire parallels Conn Maxwell’s attempt to renew Poictesme, and by extension the Federation, the same time scale may apply. Conn learns that there are “Two centuries for the Federation, as such”. (Piper, *Cosmic Computer*, p. 241) This could mean that “the First Galactic Empire comes crashing down” (Carr, Introduction to *Empire*, p. 8) about two centuries after Paul XXII, or circa AE 3136. If so, then the First Empire lasts around 1288 years, or two centuries longer than the Terran Federation, which exists for about 1066 years (circa AE 31 to 1097). This in turn means that Prince Simon Bentrík was prophetic in saying that “we’ll just have to make [government] work the best way we can, and when it breaks down, hope the next try will work a little better, for a little longer.” (Piper, *Space Viking*, p. 233) The First Galactic Empire does appear to work a little better, for a little longer, than the Second Terran Federation.

The reappearance of the Lakshmián Confederation after the Galactic Empire’s fall is based on the fact that Switzerland lasted beyond the end of the Holy Roman Empire. If I’m correct about Beam’s historical models for the later Galactic Empires, it may actually last right to the end of the Future History. (See “Piper’s System”.)

100. http://en.wikipedia.org/wiki/Military_of_Switzerland

101. See my papers “When in the Course”—Piper’s *Gods of Mars?*”, and “*Space Viking*—Piper’s *Black Swan?*” A crucial connection between the Freemasons and Switzerland may in fact exist. In *Born in Blood*, John J. Robinson makes a good case that the Freemasons began as fugitive Knights Templar. And in *The Warriors and Bankers*, Alan Butler and Stephen Dafoe present evidence that at least some of these fugitives fled France to Switzerland, where they contributed to the formation of that country. The Templars were a secretive order, as well as international bankers, and when the order was suppressed in 1307, the Templar treasure was never found. It could have become the foundation of the Swiss banking system, renowned for its secrecy and international (now global) connections.

102. http://en.wikipedia.org/wiki/The_Child_of_the_Cavern

103. http://en.wikipedia.org/wiki/The_Time_Machine

104. Corn and Horrigan, *Yesterday’s Tomorrows*, p. 118 The quote was “—Suggested by Lyman Mason”.

105. Piper, *Cosmic Computer*, p. 68

106. *Ibid.*, p. 71

107. Piper, *Cosmic Computer*, p. 79

108. *Ibid.*, p. 47

109. *Ibid.*, p. 88

110. *Ibid.*, p. 90

111. *Ibid.*, p. 91

112. *Ibid.*, p. 94

113. *Ibid.*

114. Piper, *Four-Day/Lone Star*, p. 40

115. Corn and Horrigan, *Yesterday's Tomorrows*, p. 118 The illustration is from *Science and Invention* magazine, March 1924; presumably page 1095.
116. At least ten; one on page 91, another on page 92, and eight together on page 96.
117. <http://www.sf-encyclopedia.com/entry/underground>
118. Isaac Asimov, *Foundation* (New York, NY: Avon Books, 1966), p. 16
119. Piper, *Cosmic Computer*, pp. 202, 204-205
120. *Ibid.*, p. 230
121. *Ibid.*, pp. 232-233
122. Piper, *Space Viking*, p. 165
123. Although admittedly a B-movie, one that comes to mind is "This Island Earth" (1955). In it, a couple of human scientists are kidnapped to Metaluna, an alien planet whose inhabitants have retreated underground because of unceasing war with the planet Zagon. Metaluna could be called a 'burrow-world', and it is destroyed when a constant barrage of spaceship-towed comets heats it to incandescence, turning the planet into a sun.
124. http://en.wikipedia.org/wiki/Golden_Age_of_science_fiction

