Question 1:

Dear Cheap Astronomy – Are there any missions to the Moon before Artemis

So yep, were going back to the Moon, sometime soon. NASA's first Artemis human landing mission, the crew including a woman and a person of colour (or heck why not a woman of colour, why not two) is now scheduled for 2026, remembering it was scheduled 2025 last year. But anyhow, even before that happens, whenever it happens, the CLPSs, the Commercial Lunar Payload Services, will start to arrive. The CPLS results from NASA engaging private contractors to develop landers, as well as various rovers and instrument packages that will land on those landers, all with the intention of thoroughly exploring the lunar south pole region - essentially getting the lay of the land before the humans arrive.

The first CLPS mission will probably involve the Peregrine lander, which will land Moonranger a rover the size of a small suitcase that will move largely autonomously, mapping the surface and looking for signs of sub-surface water. All going well, the little rover might be able to cover kilometres of distance, assuming it can move effectively over lunar regolith. Both Peregrine and Moonranger will be launched from Earth aboard the Vulcan Centaur rocket built by the United Launch Alliance. The Vulcan is having a few teething problems and is yet to have a maiden flight so this mission was originally scheduled for mid-2021 and is now scheduled for 2023. And this is a fairly common theme across CLPS projects, bold deadlines that get rescheduled and exciting new technological solutions that are yet to actually be road-tested, let alone regolith-tested.

But let's keep going. A later mission which is scheduled for 2023, so you-know, will involve a larger lander Griffin which will land a larger rover called VIPER, which is NASA's and hence it's actually a cute acronym for Volatiles Investigating Polar Exploration Rover. About the size of a golf cart, it's hoped that VIPER can cover several kilometers and it has a drill which can penetrate up to a metre down and it will also be looking for water. It's mission will include searching permanently shadowed areas, by running on batteries, then coming out into the Sun again to recharge from its solar panels.

Yet another lander called Nova-C will land a number of instruments at Reiner Gamma, which is a lunar swirl. Lunar swirls are somewhat puzzling surface features, essentially a curling swirl of brighter high albedo regolith. Reiner Gamma is the biggest of a several known swirls spanning about 70 kilometres of the surface. Lunar swirls are thought to be the result of a localised magnetic anomaly in the lunar crust, which is strong enough to divert the solar wind which tends to darkens most other surface features. The cause of these magnetic anomalies is unclear, though everyone is pretty confident they are not buried alien monoliths. Anyway, Reiner Gamma is definitely worth a look – both for the areas untouched by solar wind, as well as adjacent areas to which the solar wind has been deflected to and hence concentrated. Lunar swirls might even be good locations for lunar bases given they have their own little magnetic umbrella to protect the base from solar radiation.

The European Space Agency will also have a rover on board one of the commercial landers and it's also got on board with using cute acronyms, in the form of PROSPECT the Package for Resource Observation and in-Situ Prospecting for Exploration, Commercial Exploitation and Transportation. In other words, it's

a thing that going to look for stuff you can make money out of. And not to be outdone, NASA also has a project called Trident, The Regolith and Ice Drill for Exploring New Terrain

All in all, CPLS has quite a long list of landers and rovers and instrumentation packages and cute acronyms, all scheduled to arrive in the early to mid 2020s – and many may be rescheduled if things don't go quite according to plan. But hey, just the like the astronauts they will get there – sometime soon.

Question 2:

Dear Cheap Astronomy – What will the first lunar colony look like?

Well, it will probably be small and cramped and not really a colony since no-one is really going to want to spend their lives there, what with Earth just three days away – so we're probably talking sustained human activity rather than real colonization. As we've discussed before , it's going to be a very long time before we have space colonies where anyone is going to want to give birth or to grow old. So, we're anticipating something that looks like an Antarctic base from the outside and like the International Space Station from the inside. So, it will be cramped and functional, rather than spacious and comfortable. While there are radiation-protection advantages in building something underground, say within a lava tube, that would either involve constructing something from scratch or moving something prefabricated into a cavity, which would probably need a crane. So, it's more likely we'll start with modular structures that can be landed on the surface and then we'll use some front-end loaders to cover them with regolith so as to cut down on radiation. Well, let's say that's where your first long-term-stay people will live, while they start looking at constructing something bigger – which might actually be underground, but first we'd have to find a lava tube that fits the bill of being both big and accessible, as well as being near a pole where both solar energy and radio contact with Earth are available throughout the Moon's orbit around Earth.

It's likely that sustained human activity on the Moon will follow a similar path that sustained human activity in low Earth orbit had. So, we might expect there will be an initial focus on plain survival with a bit of research on the side whenever you have the time. But once some routines are established and key infrastructure is laid down and solid maintenance procedures and safety protocols are in place, then rich space tourists may start wanting to visit, which will be an economic driver to enlarge the existing facilities and to start shifting from functionality to comfort. Rich space tourists will not only want to visit, but also walk outside. So you'll need airlocks and spacesuits and eventually pressurised buses for the less adventurous, as well as for old folks and also children, who might not be born there, but will still go there with their parents. And once you have parents and children there'll be impetus to make the place clean and to reduce sharp corners and trip hazards, so then the place might then start looking like Moon colonies you see in the movies. And of course, parents with children will need family-friendly restaurants and everyone will need gift shops. So suddenly you've got yourself a whole lunar economy going with staff who need longer-term accommodation alongside the tourists who need short stay hotel

accommodation and everyone needs to eat and have access to health care and be able buy a toothbrush and do their laundry and all that stuff.

Although… before we get too starry-eyed here, let's face it submarine tourism has never really taken off. This is partly because most submarines don't have windows since it gets pretty dark down there, but it's also because a submarine is a cramped, sealed and pressurized structure within a very dangerous environment where one bad move could kill everyone on board. There are small research submersibles with big windows and external lights – but as tourist vehicles, they've never really taken off either. Of course, there is Antarctica, where a rich tourist can actually fly all the way to the pole for a cool 50 grand US. Antarctica is certainly an inhospitable place where you can die if you don't have the right gear and and it's a long way to get there without a lot of luxuries. So, maybe it's a bit like going to the Moon, but you can still breathe. So while lunar tourism is a bit of Antarctic tourism, it's also has a bit of submarine tourism and neither are huge tourism industries, apart from the Antarctic cruises, which don't really count as sustained human presence.

So, who knows, we'd be feeling a lot more confident about humanity's next giant step, if submarine tourism was a big thing on Earth today. A few rich folks do it, but it needs more than that to make a lunar economy. So, we'll see.