Investigating the Changes in the Soil Nutrients near Rocketdyne

The Center for Advanced Studies and Research

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Abstract

In 1959, A Santa Susana Field Laboratory, Rocketdyne, experienced a partial meltdown that released 28 Curies of radioactive noble gasses (ucla.edu). The impacts of Rocketdyne have been absent in the news for years, but there are still effects on the health of people living near the site. Cancer risk is higher in areas closer and the reason for that needs to be investigated as it is still an ongoing issue. We plan on measuring the pH, phosphorus, nitrogen, and potassium levels from 5 different public parks by using a soil probe to remove 6-8 inches of soil. We will use a soil sample kit to test soil from each location to identify the differences in nutrients surrounding the plant. We formed the hypothesis that if the soil is tested within different ranges of the site, a lower pH can be identified from the release of contaminants from Rocketdyne that create a more acidic soil. We would then be able to analyze the effects of the Rocketdyne meltdown and release of potential contaminants on surrounding regions. The soil samples were disposed of properly in sealed containers under professional supervision. Our results contradicted our hypothesis and we found that there are no lasting effects of the radiation of the nutrients surrounding the site.

Introduction

Background

In 1959, A Santa Susana Field Laboratory, Rocketdyne, experienced a partial meltdown that released 28 Curies of radioactive noble gasses (ucla.edu). The impacts of Rocketdyne have been absent in the news for years, but there are still prevalent effects on the public health of those living near the site, as well as the environment. A research article published by Environmental Health Perspectives monitored 2,297 people who worked at Rocketdyne for internal radiation exposure. 441 of the workers died and 134 of them died of cancer due to radiation exposure. Research regarding Rocketdyne has typically been more focused on the health impacts of those within the radius of the site, but looking into the environmental effects is also an important topic in order to fully understand the effects of the pollution from the Rocketdyne site. The soil reveals the patterns of environmental changes and near Rocketdyne, it is evident that radiation occurred. The effects of the Nuclear Meltdown at the Santa Susana Field Laboratory have caused the release of toxic materials that are negatively affecting the environment.

We plan on measuring pH, phosphorus, nitrogen, and potassium from 4 different public parks located near Rocketdyne and one park located within Simi Valley that is far from the site which will serve as a control site. Using a soil probe, 6-8 inches of soil will be removed, then we will use a soil sample kit to test soil from each location to identify the differences in nutrients surrounding the plant. The material being used are gloves, a soil probe, and the soil testing kit. If the soil is tested within different ranges of the site, a lower pH can be identified from the release of contaminants from Rocketdyne that create a more acidic soil. We would then be able to analyze the effects of the Rocketdyne meltdown and release of potential contaminants on surrounding regions. The soil samples will be disposed of properly in sealed containers under professional supervision.

The Santa Susana Field Laboratory

The Santa Susana Field Laboratory (SSFL) is a 2,849-acre property located 30 miles northwest of downtown Los Angeles in southeastern Ventura County. Its purpose was formerly a Rocketdyne rocket engine test and nuclear launch facility (Dts.ca.gov). Virtually every major U.S. space program, from the first manned Mercury flights to the Apollo moon landings and Space Shuttle fleet, owes part of its success to the field lab in California's Santa Susana Mountains. It was also the site of energy research and development for the U.S. government, including leading-edge nuclear, solar, and sodium reactor technology. These past operations left residual chemical and radiological contamination in soil and groundwater. Numerous health studies conducted by government agencies, university researchers and others have examined cancer rates in the communities surrounding Santa Susana. Taken together, the studies do not support a link between an increased incidence of cancer and past operations at the site. Since 1996, Boeing has been working to clean and preserve the environment.

pH

The first substance being measured in each soil sample is pH. pH is a basic measure of acidity with a range going from 0-14. 0 is the most acidic, 7 is neutral, and 14 is the most basic. More specifically, pH is really a measure of the relative amount of free hydrogen and hydroxyl ions (usgs.gov). For the purpose of this study, we will be using pH as a determining factor of the radioactive effects and remnants in the soil surrounding the SSFL. Typically, pH measurements show significant differences between radiated materials and non-radiated materials. Correspondingly, radioactive materials contain the highest, and thus most basic, pH levels (Department of Soils and Water…, 1978). pH is vital to plant life because it influences the key

nutrients available to plants and their ability to uptake and absorb necessary nutrients (cropnutrition.com)

Nitrogen (N)

The second substance being measured in each soil sample is Nitrogen. It is a colorless, odorless, tasteless gas that is the most plentiful element in Earth's atmosphere and is a constituent of all living matter. The absorption of ionizing radiation by living cells can directly disrupt atomic structures, producing chemical and biological changes, which is heavily apparent in nitrogen levels (Azzam et al., 2014). This means that excessive amounts of radiation can oxidize (change as a result of the influx of oxygen), which accordingly depletes the level of nitrogen. Nitrogen levels play a large role in the cellular functions of the plants' energy is available for their growth (cropnutrition.com).

Potassium (K)

The third substance being measured in each soil sample is potassium. Potassium is a silvery-white metal that is soft enough to be cut with a knife with little force. Radiation causes an almost two-fold increase in potassium and significantly increases extracellular potassium (Winter et al., 2014). Potassium is a critical nutrient that plants absorb from the soil, and from fertilizer. It increases disease resistance, helps stalks to grow upright and sturdy, improves drought tolerance, and helps plants get through the winter. Radiation could upset the balance of potassium and plants and cause drastic effects on their soil and growth (cropnutrition.com).

Phosphorus (P)

The fourth and final substance being measured in each soil sample is phosphorus. Phosphorus is a highly reactive element that is a major component of the cell membrane structure

and a key energy source, ATP. Many proteins and sugars in the body are phosphorylated. Radiation can cause a major increase in phosphorus levels and lead to the possible formation of radioactive phosphorus, which can pose a major threat to plant life (NIH). This poses a threat because a balanced phosphorus level is vital to all plant life for harvesting the sun's energy and converting it into growth and reproduction (cropnutrition.com).

Materials

Item	**Quantity**
12 inch soil probe	1
Luster Leaf 1601 Rapitest Soil test kit	10 Nitrogen 10 Potassium 10 pH 10 Phosphorus
Cell Phone	1
Gloves	3 pairs
Journal/pen	1
Mini plastic Bags	20
Plastic Test Tubes/Containers	6
Eyedropper	1
Distilled Water	1 gallon

Procedures

1. We will go to 5 different public parks surrounding Rocketdyne to collect 2 soil samples from each park (approximately 1 bird's eye mile apart from each other) . Parks were chosen based on the parks with the closest proximity to the SSFL, in a circle outlining the site. All parks were also

chosen based on the availability of soil that can be obtained and measured. We will also collect two soil samples from one public park in Simi Valley that is located farthest from the site as our control because it would be in the same park district and undergo the same maintenance but be far away enough from the site to not be affected by the pollution (four parks and 1 control because our soil test kit only has 20 tests so we will complete 1 test at each park). We chose 5 parks because of their close proximity to the original meltdown and due to the limited number of tests we have. These parks include Runkle Canyon Park, El Escorpion Park, Arroyostow Park, Sage Ranch Park, Castle Peak Park, and control at Thousand Oaks High School.

2. We will use a 12 inch soil probe to remove 6-8 inches of deep soil at each park
3. We will use a Luster Leaf 1601 Rapitest test kit to test the soil from each location to identify the differences in pH, nitrogen, potassium, and phosphorus between each location. This soil sample kit was chosen based on the elements that it measures, which we can use to reveal the possible effects of the SSFL on plant life. The plant life will be noted through qualitative observations as there is no way to measure plants at public parks. The soil will be brought back to the Core for testing. We will test the soil by putting each soil sample in a clean plastic container and removing any rocks or branches from each container.
4. For the pH test, we will fill the test chamber with the soil sample to the fill line. Then we will have to separate the two halves of the green capsule and pour powder into the test chamber. Next we will use the dropper provided to add water in the test chamber to the water fill line and put the cap on the chamber to shake the test kit thoroughly
5. For the Nitrogen, Phosphorous, and Potassium tests, we will fill a clean container with 1 cup of soil and 5 cups of water. In the container, we will shake or stir the soil and water together for at least one minute and then we will let the mixture sit undisturbed until the mixture separates (30 minutes to 24 hours depending on the soil). Next, we will use the dropper provided to fill the test

and reference chambers to the fill line with the water and soil solution we created from the soil sample. Then we will use one of the colored capsules that match the according test and separate the two halves of the capsule and pour the powder into the test chamber. Next we will put the cap on the test chamber and shake thoroughly. We will let the test sit for 10 minutes to allow the color to develop.

6. For each test, we will compare the color of the soil sample to the color chart to distinguish the pH, Nitrogen, Phosphorus, and Potassium levels
7. We will compare the levels of these materials to the same materials from the soil at a controlled site situated outside of the Rocketdyne exposure territory. Inherent factors, such as fertilizer and runoff, pose possible limitations, but assuming that Simi Parks and Rec treats all parks the same, there shouldn't be other conflicting factors.
8. We will statistically analyze data collected to determine the effects of Rocketdyne on soil nutrition.

Results

The independent variable is the distance of the soil samples from the original meltdown site. Based on the location of the park in correlation to the Rocketdyne site, the nutrients of the soil would be affected. Throughout all of the tests, the potassium and pH were most apparent almost immediately whereas nitrogen and phosphorus took longer to show a hint of color.

Soil Location	**pH Level**	**Nitrogen Level**	**Potassium Level**	**Phosphorus level**
Runkle Canyon Park	7.0 neutral	N0 Depleted	K4 Surplus	P0 Depleted
Arroyostow	7.0 neutral	N0 Depleted	K3 sufficient	P0 Depleted

Park				
Sage Ranch Park	7.0 neutral	N0 depleted	K1 Deficient	P0 depleted
Castle Peak Park	6.0 acid	N0 depleted	K3 sufficient	P0 depleted
El Escorpion Park	6.0 acid	N1 Deficient	K4 surplus	P0 depleted
Thousand Oaks Sample:	6.0 acid	N1 deficient	K4 surplus	P1 deficient

Discussion

Runkle Canyon Park

The soil of Runkle Canyon Park measured a neutral pH (7.0), a depleted nitrogen level, a surplus of potassium, and depleted phosphorus. Runkle Canyon's soil was dense, a light brown color, and difficult to obtain/dig into dirt with the soil probe. The surroundings of the dirt extraction site contained various weeds and trees but little flourishing plant life. The completely neutral pH shows healthy levels that don't reflect any effects of radiation on its nutrients. The depleted nitrogen levels also don't reflect any effects of radiation because according to our research, radiation causes excess nitrogen levels that can have adverse effects on plants and soil. Runkle Canyon had a surplus of potassium, which is reflective of Radiation effects, which has been shown to significantly increase potassium. However, this could be purely correlative or due to other factors because it is not consistent with other nutrient levels and their relationship to radiation. Finally, radiation can leave a surplus of phosphorous levels, but Runkle Canyon showed depleted levels, signifying no effects of radiation.

Arroyostow Park

The soil of Arroyostow Park measured a neutral pH level (7.0), a depleted nitrogen level, a surplus of potassium, and a depleted phosphorus level. The soil among Arroystow was also dense, a slightly darker color than Runkle Canyon, and required more effort to dig in the probe. This soil was surrounding a tree, surrounded by plants, but had little other plant life. The neutral 7.0 pH represents healthy levels of pH, not reflecting exposure to radiation. Radiation causes excess nitrogen levels, which are not reflected by the depleted levels of nitrogen at Arroyostow. Runkle Canyon had a surplus of potassium, which is reflective of Radiation effects, which has been shown to significantly increase potassium. However, this could be purely correlative or due to other factors because it is not consistent with other nutrient levels and their relationship to radiation. Finally, radiation can leave a surplus of phosphorous levels, but Runkle Canyon showed depleted levels, signifying no effects of radiation.

Sage Ranch Park

The soil taken from Sage Ranch Park measured a neutral pH level (7.0), a depleted nitrogen level, a sufficient level of potassium, and a depleted level of phosphorus. Sage Ranch Park had the loosest soil and was an orange-brown color. This was by far the easiest soil to obtain and was surrounded by luscious plant life. The neutral pH level of the soil shows that the soil is healthy which means it has not been affected by radiation exposure. Radiation exposure causes an increase in nitrogen levels however the soil from Sage Ranch Park has a depleted level of nitrogen meaning the soil was not affected by the radioactivity. Although the soil did have a sufficient level of potassium and radioactivity exposure causes

an increase in potassium levels, this is not consistent with the other nutrient levels and their relationship with radioactivity. Lastly, radioactivity exposure causes a surplus of phosphorus levels and the soil from Sage Ranch Park had a depleted level of phosphorus concluding that the soil from Sage Ranch Park was not affected by radioactivity exposure.

Castle Peak Park

The soil from Castle Peak Park measured an acid pH level (6.0), a depleted nitrogen level, a surplus of potassium, and a depleted level of phosphorus. Castle Peak Park's soil was also an orange-brown color with darker hints of brown. This soil was quite rocky, and somewhat difficult to obtain, not surrounded by as much luscious vegetation as Sage Ranch, but still more than the first two samples received. Radioactivity exposure causes soil samples to have high pH levels that are more basic (14.0), but the soil from Castle Peak Park has an acid pH level (6.0) determining that the soil was not affected by radioactivity. Radioactivity also causes an excess of nitrogen, but the soil from Castle Peak Park had a depleted level of nitrogen meaning there was no effect of the radioactivity on the soil sample. Although radiation exposure causes a surplus of potassium and the soil from Castle Peak Park had a surplus level of potassium, this is not consistent with the other nutrient levels and their correlation to radioactivity exposure so the surplus of potassium could have been caused by other factors. Lastly, radioactivity causes an increase in phosphorus levels and the soil from Castle Peak Park had a depleted level of phosphorus which concludes that radioactivity had no effects on the soil.

El Escorpion Park

The soil from El Escorpion Park measured an acid pH level (6.0), a deficient level of

nitrogen, a surplus level of potassium, and a deficient level of phosphorus. El Escorpion's soil was loose, rocky, and dark brown. It was easy to obtain, surrounded by almost zero vegetation of any kind, other than trees and dead grass. Radioactive materials contain the highest, most basic levels of pH, so this slightly acidic, 6.0 pH level in the soil of El Escorpion Park does not reveal signs of radiation. Excess nitrogen levels can be results of radioactivity, which is not apparent as El Escorpion contains deficient levels of nitrogen. This park has a surplus of potassium, which is reflective of Radiation effects, which has been shown to significantly increase potassium. However, this could be purely correlative or due to other factors because it is not consistent with other nutrient levels and their relationship to radiation. Radiation can leave a surplus of phosphorous levels, but El Escorpion Park showed depleted levels, signifying no effects of radiation.

Control

Soil was taken from the Thousand Oaks Community Center park, but it is apparent that the soil located near Rocketdyne had similar properties. There were no significant differences between the control. All soil samples were consistent in having depleted or deficient phosphorus and nitrogen, having sufficient or surplus of potassium, and having a pH between 6.0 and 7.0. This soil sample contained compact, light brown dirt surrounded by drought-tolerant plants, and difficult to obtain. This slightly acidic-normal pH level demonstrates no effects of radioactivity on this soil. Deficient Nitrogen levels also correlatively do not show signs of radiation. The control sample had a surplus of potassium, which while it can be an effect of radiation, is not consistent with the other nutrient levels and their correlation to radioactivity exposure. Finally, deficient levels of phosphorus at the

Thousand Oaks High School control site show no effects of radiation.

Correlation

All nutrients measured were mostly consistent among all 5 parks surrounding the Rocketdyne nuclear meltdown site, as well as the control site at Thousand Oaks High School. Additionally, the levels of nutrients found at each park show no effect of radiation on nutrients in soil, except for Potassium. Potassium levels were in a surplus at 3/6 locations, which while is an effect of radiation, is not consistent with the other levels of nutrients that do not show any signs of radiation.

Conclusion

Based on what was tested in this experiment, the effects of the radioactivity exposure from the Rocketdyne laboratory site have little to no effect on the soil and dirt in Simi Valley, California. For example, our results show that the soil samples collected from public parks located around the Rocketdyne site have a neutral (7.0) or acid (6.0) pH levels and materials that have been affected by radioactivity tend to have high pH levels that are more basic (14.0) according to previous studies. Additionally, if the radioactivity affected the soil, we would have seen surpluses across all of the nutrients that we tested, but the only surplus that we saw was potassium. This surplus was also seen in the soil of our control which eliminates the potential effect that radioactivity would have left. Instead, there were deficiencies and depletion which can be attributed to other factors that are unrelated to Rocketdyne. These results contradicted our original hypothesis that the nutrients would display noticeable differences as the soil samples got closer to the Rocketdyne site. When comparing our samples to our control, the soil samples shared many of the same characteristics

which leads to our conclusion that the radioactivity from Rocketdyne no longer affects the nutrients within the soil of nearby areas.

Limitations/Future Research

We didn't get to conduct multiple tests for each element due to the lack of testing available within our budget. Moreover, this means we could have faulty tests since we only did one per sample. Additionally, our research did not measure levels of radiation directly, merely correlative factors that don’t necessarily reveal radioactivity. This study needed to have the nutrients along with the radioactivity levels in order to precisely identify whether the radioactivity had an effect on the soil of surrounding areas. The lack of differences may also be due to the fact that only the top soil was tested because we didn't have access to get soil from a greater depth. Furthermore, Simi Valley Parks and Recreation district handles all of the parks in the same manner meaning that they all display similar characteristics because the topsoil consists of the same fertilizer and soil.

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