Table 1. Mean diameters of nucleoli 30 days after implantation of estradiol-containing or empty 27-gauge stainless steel tubing into the arcuate or mammillary nucleus. Diameters measured in millimeters at a magnification of 5200.

Sex	No. of rats	Mean diameter ± S.E.M.	*t*-test
		Estradiol→arcuate	
F	11	10.1 ± 0.1	P< 0.001
		Empty tube→arcuate	
F	8	11.2 ± 0.4	
		Estradiol→arcuate	
M	8	10.2 ± 0.2	P< 0.01
		Empty tube→arcuate	
M	6	10.7 ± 0.2	
		Estradiol→mammillary	
F	4	9.6 ± 0.3	*
		Empty tube→mammillary	
F	2	11.7 ± 0.3	*

* No *t*-test run for groups of less than five.

in order to demonstrate any changes in the neurons of those nuclei in which hormone implant had resulted in atrophy of the gonads. Nucleolar size varies significantly depending upon the activity of the neuron (*3*). Therefore, measurements of the mean nucleolar diameter may be considered a valid criterion of hormonal influence on the neuron.

In the female rat atrophic changes in the gonads occurred when estradiol was implanted in either the arcuate or mammillary nucleus, while in the male similar changes only occurred from a hormone implant in the arcuate nucleus. Measurements were made, therefore, on the nucleoli of these cell groups, and the nucleolar diameters for experimental and control groups were compared.

The data presented in Table 1 demonstrate that implants of estradiol in the nucleus arcuatus resulted in a significant decrease in mean nucleolar diameter in both male and female rats. In the female rat there was a similar decrease in nucleolar size as a result of hormone implants in the mammillary nucleus. Although this series was too small to permit statistical analysis, the trend is apparent. Implants of estradiol at sites in the hypothalamus other than the arcuate nucleus never resulted in significant change in the nucleolar diameter of arcuate neurons.

The nucleolar measurements were made on sections from the brains of the animals described in our 1960 paper (*1*). In all cases 27-gauge hypodermic tubing containing crystalline estradiol within the lumen, or similar empty tubing, had been stereotaxically implanted in one of the hypothalamic nuclei of adult, intact, male or female rats; the implants remained for 30 days. After autopsy the brains were paraffin sectioned at 15 μ and stained with thionine.

For each animal, between 60 and 100 nucleoli, while magnified under an oil immersion lens, were photographed with a 35-mm camera, on high-contrast copy film. This film was studied in a microfilm reader and the mean diameters of the nucleoli were measured with an accurate rule graduated in half millimeters. This method of measurement yielded a linear diameter of 5200 times the actual size. Analysis for significance was by Student's *t*-test for groups of unequal numbers.

The data thus indicate that hypophysectomy-like atrophy (*1*) of the reproductive tract of the rat, following estradiol implant in the hypothalamus, is accompanied by a significant decrease in the size of the nucleoli of either the arcuate or mammillary neurons. Since the gonadal atrophy presumably results from a deficiency of gonadotrophin in the circulation, the arcuate and mammillary nuclei in the rat must play an important role in the release of gonadotrophin. Ifft (*4*) has measured nucleolar size for most of the hypothalamic nuclei of rats that were subjected to varying scheduled periods of light and dark and treated with a number of different pharmacological agents. The only nucleus in which changes in nucleolar size could be consistently correlated with the stage of the estrous cycle was the nucleus arcuatus.

Recently, extracts have been prepared from stalk-median eminence material of the rat. Such a tissue extract should include all the neurons of the arcuate nucleus and probably some of the mammillary nuclear area as well. Intravenous injection of this tissue extract resulted in depletion of ovarian ascorbic acid (*5*), which indicated the presence of a factor that releases luteinizing hormone (LH) (*6*). When the pituitary of a rat in which normal ovulation had been blocked by pentobarbital was infused with a similar extract the rat ovulated (*7*); this demonstrates that a definite link in the ovulation process is contained within this region.

Although there is no striking anatomical evidence for direct links between the neurons of the arcuate nucleus and the anterior pituitary, the above data strongly suggest that this region of the brain regulates the physiological state of the gonads and the process of ovulation through the rate of release of some neural substance(s). When estradiol is implanted in this area the significant decrease in nucleolar size is strong indication that these neurons are directly responsive to the amount of estrogen circulating in the system. Furthermore, the increased estrogen results in a decreased synthesis of some humoral substance by the arcuate and mammillary neurons (*8*).

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Isotopic Fractionation of Uranium in Sandstone

Abstract. *Relatively unoxidized black uranium ores from sandstone deposits in the western United States show deviations in the uranium-235 to uranium-234 ratio throughout a range from 40 percent excess uranium-234 to 40 percent deficient uranium-234 with respect to a reference uranium-235 to uranium-234 ratio. The deficient uranium-234 is leached preferentially to uranium-238 and the excess uranium-234 is believed to result from deposition of uranium-234 enriched in solutions from leached deposits.*

Natural variations in the ratio of U^{234}/U^{238} have been discovered recently. Activity ratios of U^{234}/U^{238}, 1.7 to 2.3 in carbonates, from pluvial Lake Bonneville, Utah, were measured by Thurber (*1*) by means of an alpha spectrometer. On the basis of alpha-particle measurements, Russian scientists have reported several variations in U^{234}/U^{238} activity ratios: 1.2 to 1.6 in eight bone samples (*2*); 3.1 in schroekingerite mineral (*3*); 1.11 in a uranium-enriched water sample (*4*); 7 to 8 in surface water samples; and a ratio of greater than 4 in a bone sample (*5*). Previous radiochemical disequilibrium

studies in uranium ores (*6*, *7*) were based on analyses of Pa^{231}, Th^{230}, and Ra^{226} compared to total uranium determined by standard chemical methods. A more complete radioisotopic distribution in uranium ores should include U^{238} and U^{234} isotopes. U^{234} is a radioactive daughter product of U^{238} in the decay scheme:

$$U^{238} \xrightarrow{t_{1/2} = 4.5 \cdot 10^9 \text{ yr}} Th^{234}$$

$$Th^{234} \xrightarrow{t_{1/2} = 24 \text{ day}} Pa^{234}$$

$$Pa^{234} \xrightarrow{t_{1/2} = 1.1 \text{ min}} U^{234}$$

$$U^{234} \xrightarrow{t_{1/2} = 2.5 \cdot 10^5 \text{ yr}} Th^{230}$$

One gram of uranium of normal isotope abundance in equilibrium with its decay products would contain the amounts and activities of decay products indicated in Table 1.

Our investigation of uranium isotope ratios includes 28 different sandstone ores from nine major uranium districts in western United States; black uranium ores were primarily studied. Significant variations were found for the U^{235}/U^{234} ratio in most of the samples analyzed. No significant variations for the U^{235}/U^{238} ratio were found at the ½-percent level in the samples. The abundance measurements were made on a 12-inch, 60-degree-sector mass spectrometer. The ion current for the U^{234} beam was approximately 10^{-16} amp and was measured with an ion multiplier driving a Cary vibrating reed electrometer.

Table 2 shows the percentage difference, δ, as the deviation from unity of the U^{235}/U^{234} ratio in each ore sample to that in the National Bureau of Standards natural uranium reference sample, where

$$\delta = 100 \left[\frac{U^{235}/U^{234}\text{ (reference)}}{U^{235}/U^{234}\text{ (sample)}} - 1 \right]$$

In Table 2 descriptions, such as pre-fault, post-fault, and stacked uranium ore in the Ambrosia Lake district, have been defined by Granger *et al.* (*8*). The sulfide, transition, and oxidized zones in the Happy Jack mine have been mapped by Trites *et al.* (*9*), and the Shirley Basin rolls have been described by Harshmann (*10*).

Large deficiencies of U^{234} are attributed to leaching of U^{234} preferentially to U^{238} and U^{235}. The ores investigated are relatively young geologically (*8*), and, hence, radiation damage may be slight; nevertheless, the recoil effect of one alpha particle disintegration and the differing chemical affinities between

Table 1. Amounts and activities of decay products in 1 gram of uranium of normal isotope abundance in equilibrium with its decay products.

Nuclide	Content (g)	Activity (disintegration/min)	
		Alpha	Beta
U^{238}	0.9928	734,600	
Th^{234}	1.4×10^{-11}		734,600
Pa^{234}	4.7×10^{-17}		734,600
U^{234}	5.4×10^{-5}	734,600	
U^{235}	0.0072	33,800	

uranium and the intermediate daughter products, Th^{234} and Pa^{234}, result in disruption of the chemical bonds of the original U^{238} atoms which have decayed to U^{234}. Production of U^{234} in the hexavalent state probably results after stripping of the electrons from the decayed nucleus, and, except in highly reducing environments, the stable form of UO_2^{+2} would be attained before the U^{234} atoms could return to the original U^{+4} state predominant in most of the black ores investigated. Thus U^{234} would differ from much of the U^{238} in oxidation state, in location in interstitial spaces, and in type of chemical bonds. Differential chemical behavior of Th^{234} and uranium may cause some isotopic differences during formation of ores. The isotopic fractionation observed probably is the result of a combination of these factors.

The data in Table 2 show no apparent differences in the relative amount of U^{234} that can be leached from black ores compared to that from oxidized and from highly leached oxidized ores. Organic matter in significant to large amounts is associated with all the black uranium ores studied, and uranium forms strong organic complexes at the time of its initial introduction under highly reducing conditions (*11*). At the present time a less reducing environment exists in the ores investigated, and therefore recently created U^{234} may not form the strong complexes which are characteristic of the original uranium ore. In the oxidized ores subjected to considerable surface water oxidation, both U^{234} and U^{238} would be in the oxidized state; however, differentiation of the two isotopes exists in about the same proportion as in black ores. This suggests that complete oxidation by surface weathering may play a minor role in differential leaching of uranium. Differences in which isotopes are fixed by definite chemical bonds in minerals or

Table 2. Percentage difference, δ, from unity of the U^{235}/U^{234} ratio in sandstone ore samples to that in the reference sample.

U.S.G.S. serial No.	Black uranium ore	δ (%)
	Relatively unoxidized	
262308	Carbonate rich ore, Runge mine, Fall River County, S.D.	− 3.7
263465	Uraninite from vein material, Runge mine	− 3.5
271418	Mill pulp sample, Hauber mine, Crook County, Wyo.	+ 0.1
269011	Uranium ore channel sample, Hauber mine	+ 3.5
273050	Drill core sample, Shirley Basin district, Fremont County, Wyo.	− 3.7
288987	Uranium ore from roll structure, Shirley Basin district	−19.1
272324	High-grade ore pod, Gas Hills area, Fremont County, Wyo.	+ 0.4
273092	Uranium ore from roll, Gas Hills area	+10.1
272327	High-grade ore pod, Crooks Gap area, Fremont County, Wyo.	+ 1.1
MP-1	Pitch mine ore, Marshall Pass area, Saguache County, Colo.	−27.4
211899	Drill core sample, 809′ depth, San Miguel County, Colo.	+ 1.2
256468	Upper channel sample, MiVida mine, San Juan County, Utah	−40.7
256462	Lower channel sample, MiVida mine	+ 2.7
207400	Sulfide zone ore, Happy Jack mine, San Juan County, Utah	− 1.9
207413	Transition zone ore, Happy Jack mine	+19.0
268943	Pre-fault black ore, Ambrosia Lake district, McKinley County, N.M.	− 1.0
271939	Post-fault black ore, Ambrosia Lake district	−21.9
271940	Post-fault black ore, Ambrosia Lake district	−16.6
277965	Post-fault purple ore, Ambrosia Lake district	+40.7
284276	Post-fault stacked uranium ore, Ambrosia Lake district	− 2.3
284270	Uraninite ore, Gambler Pit, Karnes County, Tex.	+ 1.8
246885	Drill-core sample, Palangana Salt dome, Duval County, Tex.	− 3.3
APP-1/62	Uranium-bearing asphaltite from sandstone, Mine LaMotte, Madison County, Mo.	− 0.3
	Oxidized by surface water	
252412	Carnotite-Tyuyamunite ore, Hulett Creek, Crook County, Wyo.	− 8.9
57623	Schroeckingerite-bearing rock, Sweetwater County, Wyo.	− 6.1
229191	Oxidized zone ore, Happy Jack mine	− 6.1
229184	Leached ore, oxidized zone, Happy Jack mine	−29.0
SH-27-56	Carnotite ore from roll structure, San Miguel County, Colo.	− 1.1

organic complexes probably play the predominant role. Once these bonds are disrupted, uranium becomes an exceedingly mobile element in the presence of water containing carbonate and bicarbonate ions.

Based on geologic evidence, the samples that contain U^{234} in excess greater than 10 percent are believed to represent redistributed uranium. Thus a significant portion of U^{234} preferentially leached from other uranium-bearing rocks is subsequently deposited in excess in at least some parts of the redistributed uranium ore bodies *(12)*.

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Weather Control: Use of Asphalt Coatings To Tap Solar Energy

Abstract. *Coating the ground with black asphalt will increase soil temperatures as much as 19°F. On the other hand, if freshly applied asphalt is used as a binder for a white material such as gypsum or lime, subsurface temperatures can be dropped as much as 24°F. The cost and permanence of such coatings might permit their use to cover very large areas of the earth, and the coatings might prove effective in modifying weather.*

The tremendous energy involved in the weather phenomena which affect our planet is derived entirely from the sun. Sunlight, however, is not absorbed directly by the atmosphere except for the absorption of a small amount of ultraviolet light by the ozone at altitudes above the stratosphere. To enter into the earth's atmosphere, the solar energy must first be absorbed at the surface of the earth. This surface acts as a converter to distribute the absorbed energy between the earth and the atmosphere by conduction, radiation, diffusion, and vaporization processes.

It has long been thought that man could control the weather if he could find a practical and inexpensive method for changing the ability of large areas of the earth's surface to absorb and convert solar energy. Methods suggested for accomplishing this were recently reviewed by Wexler *(1)*. The most promising suggestion to date has been the spreading of powdered coal, but it has been recognized that the permanence and hence the practicability of such coatings is doubtful. There are also no experimental data on the surface temperature increases which such a procedure might be expected to produce. My report presents evidence which shows that important differences in the ability of the earth's surface to absorb and convert solar radiation can be produced by asphalt coatings, which have been demonstrated to be long-lived and inexpensive to apply.

The absorptivity of sandy soil or most vegetation to solar radiation varies from 70 to 80 percent. By the application of a black asphalt coating, absorptivities of about 95 percent can be achieved. Conversely, if the freshly applied asphalt coating is used as an adhesive for a white reflecting material, such as gypsum or lime, the absorptivity can be reduced to about 25 percent.

The amount of solar energy incident upon the earth on a clear summer day in the temperate zone or almost any sunny day in the tropics is about 500 to 600 cal/cm^2; this amounts to 15,000 to 18,000 Mwatt/mi^2. A 20 percent increase in absorptivity by the surface can, therefore, make enormous amounts of additional energy available for atmospheric effects if the change is effected over a sufficiently large area.

The temperature changes which either a black asphalt coating or a white one covered with gypsum will produce have been evaluated in a field test in Arizona. The coatings were laid down both as 8-inch wide strips and as 10- by 10-foot squares. Thermocouples connected to temperature recorders were buried at various depths below the center of each test patch and also under an uncoated adjacent control area. It was found that the 10-foot-square coatings produced temperature effects which were about twice that recorded under the strips. The data for the square coatings are presented in Table 1. Here it can be seen that the application of a black asphalt coating raised soil temperatures about 19°F ½ inch below the surface when soil temperatures reached a maximum during the afternoon, and that a 4.4°F advantage still persisted at this depth even when the soil was coldest during the night. Conversely, a white coating gave a maximum temperature which was 24°F below that of the control area at ½-inch depth. The actual surface temperature, which controls radiative and convective heat transfer into the atmosphere, would show even greater effects than the ½-inch readings just quoted.

These data appear promising for the initiation of meteorological phenomena. The difference of 43°F between the black and white coated soil temperatures is as large as the difference between average summer and winter temperatures in most temperate zone climates. The difference of 19°F between the black asphalt coated area and the control is enough to cause an increased infrared radiation flux of about 170 Mwatt/mi^2, even assuming that both surfaces have perfect infrared emissivity.

Landsberg *(2)* has stated that the temperature of the surface is undoubtedly directly responsible for the air temperature up to considerable heights, at least for several thousand feet, and that the effect may extend even further aloft. This and other meteorological information gathered to date suggest that the application of asphalt coatings over tens or hundreds of square miles of the earth's surface could produce useful changes in local weather. Relatively thin, inexpensive coatings should prove adequate in respect to permanence since they would not be exposed to traffic or other adverse conditions.

Cumulus cloud formation is frequently induced by differential heating and it has also been suggested that surface heat sources play a significant role in localizing cumulonimbus clouds and