FIERY FORCES THAT CAUSE VOLCANIC ERUPTIONS

JAMES F. KEMP, PROFESSOR OF GEOLOGY AT COLUMBIA COLLEGE, WRITES ON A DISPUTED SUBJECT

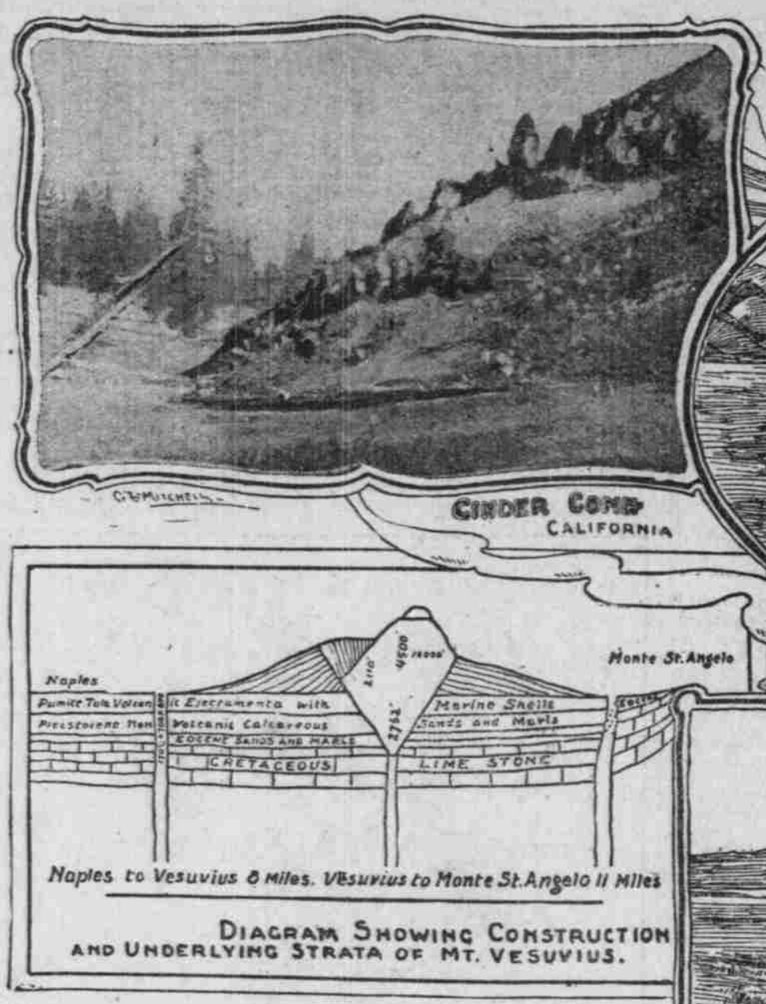
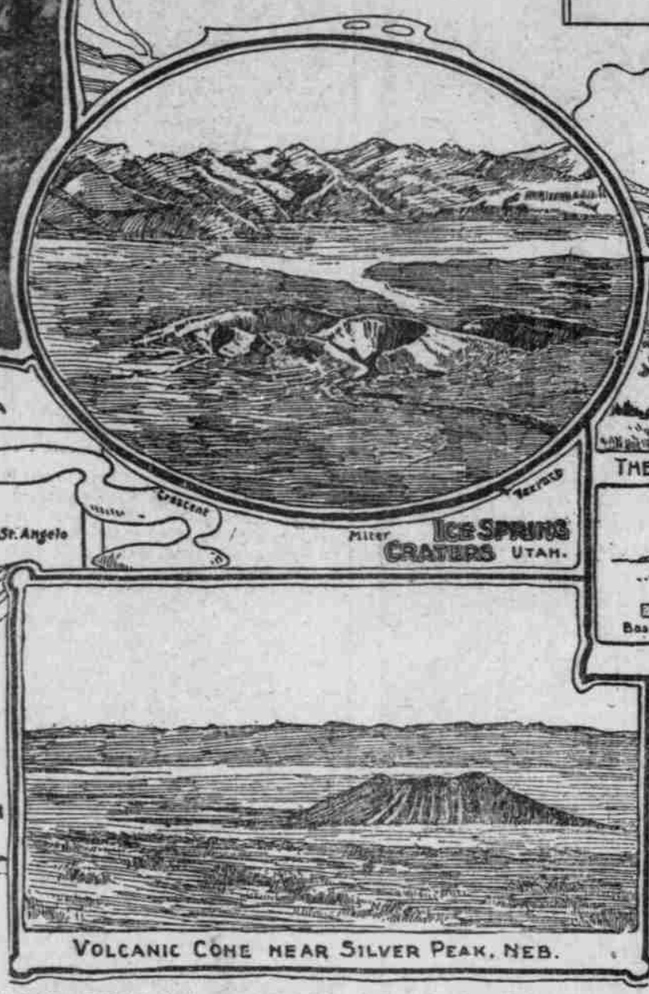
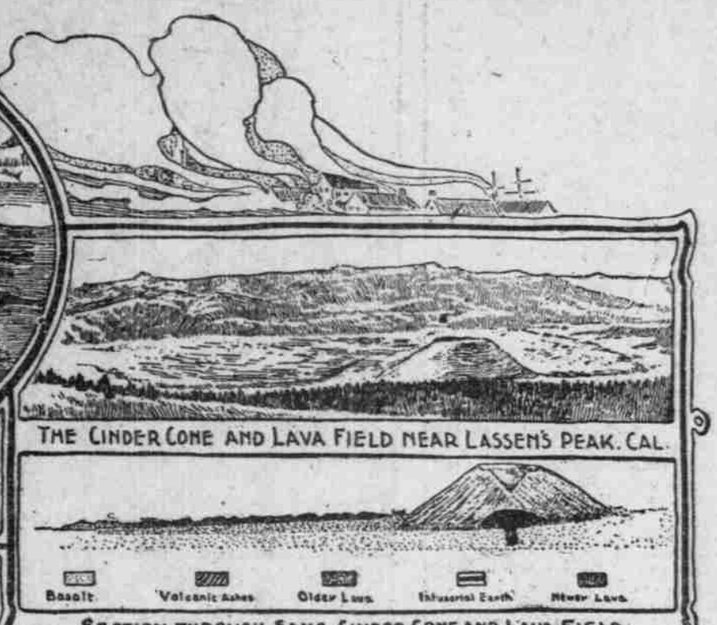


DIAGRAM SHOWING CONSTRUCTION AND UNDERLYING STRATA OF MT. VESUVIUS.



VOLCANIC CONE NEAR SILVER PEAK, NEB.



THE CINDER CONE AND LAVA FIELD NEAR LASSEN'S PEAK, CAL.

SECTION THROUGH SAME CINDER CONE AND LAVA FIELD.

THE recent volcanic outbreaks in the West Indies have aroused great interest in this particular form through which the interior heat and energy of the earth manifest themselves, and have raised questions of a scientific nature in the minds of a great many who had not previously given them much attention. These questions are not only attractive but direct investigation of them involves some elements of danger, and they are, withal, a bit uncanny.

All that we know in a general way about volcanoes and their attendant earthquakes has been accumulated by patient observation of both active and extinct cones and by interpretation of the observations in accordance with sound principles. Geology in this particular does us all great service because it brings to our aid in connection with the outbreaks in the Lesser Antilles the results of much careful work in all quarters of the globe, lasting through centuries and performed by many observers. If then, we briefly state the order of events in the West Indies we may afterwards see how well they conform to a few general principles, which have been established in this manner.

Mount Pelee, in Martinique, and La Soufflere, in St. Vincent, have been recognized as old craters since their discovery, but it is a long time, 20 years in fact, since the latter was active. A lake even accumulated in one of the craters. Gradually in the early part of May there were symptoms of reviving activity. Earthquake shocks were felt in their neighborhood; clouds of steam and other gases started up from the old vents and showers of dust and stone were blown into the air, because the vapors burst forth with explosive violence. As the days passed the violence increased, and soon an explosion of special efficiency in Mount Pelee tapped off a flood of molten rock which coursed in a destructive tide down the mountain. A day or two afterward a furious outburst cast the hot dust and clouds of lava over St. Pierre and utterly destroyed it.

On St. Vincent, at this writing, dust and larger fragments and gases have been the main emissions and have caused the principal loss of life and damage. It is reported that the bottom of the sea has sunk several fathoms near Georgetown, and that thus a considerable dislocation of the crust is indicated.

Islands Raised From Sea's Depths.

All the Lesser Antilles, from Saba through the Grenadines and Grenada, are of volcanic region, and they hail from the depths of the sea. We have no means of knowing their exact structure, but from our fuller knowledge of Vesuvius, as shown in the accompanying diagram, we can draw a pretty close inference.

Vesuvius rests upon the following described foundation, as has been shown by deep borings in Naples, and by the mountain ridge of St. Angelo farther southeast.

The lowest stratum is limestone of undetermined thickness. The volcano occasionally casts out blocks of it borne aloft from below.

Next above this is 150 feet of sandstone; then 700 fet of calcareous sandstone.

On the top of the last-named (first as a submarine vent and apparently in about 600 feet of water) the young volcano built up a great layer of dust and fragments 600 feet thick. Throughout this material are found marine shells. When the 600 feet had been accumulated the vent had risen above the water and was able to construct the old crater known to the ancients. But before human records begin, the activity ceased, and at 700 B. C., the cone was cold and dead. Suddenly in the year 63 A. D., it showed signs of activity, and 16 years after the usual warnings it broke out explosively, in 79 A. D., and buried up Pompeii with its thousands of inhabitants. From that time to the present it has been quiet only for comparatively short periods.

In much the same way the cones and islands of the Lesser Antilles must have been reared. During periods of activity beds of fine and coarse fragments of volcanic rock have gathered in great quantity. Floods of lava and large masses intruded into fissures have bound them into a solid aggregate; islands and island cones have been raised above the sea until the present conditions have been reached.

Now, why do volcanoes break out? A number of points are involved in an answer to this question. We know in the first place that the earth grows hotter as we descend, and at rates that have been measured in deep mines and bore holes as shown in the accompanying table:

	No. of feet for 1 degree, F.	Total depth measured.
Central Copper mine, Michigan	101	1960
Wheeling, W. Va., boring, 80 to	50	1350
Wheeling, W. Va., boring	69	4462
Schladabach, Sax	65	5749
Yakutsk, Siberia	60	656
Geneva, Switzerland	35	....

If we select an average rate of about 60 feet of descent for an increase of one degree Fahrenheit and carry it out for 25 miles, we reach a temperature of 2200 degrees, which is just about that of ordinary molten lava. Coupling this with the facts known about volcanoes, it was natural for early observers to conclude that the interior of the earth was molten, and that mankind lived on a crust 25 miles thick or more.

But the astronomers and mathematicians soon reminded the geologists that the earth is a rapidly rotating body which is subject to the deforming effects of centrifugal force, and to the attractions of the moon and other heavenly bodies which are believed to cause the oceanic tides. They made the point that the earth behaves like a body as rigid as steel. They therefore rejected the conception of a fluid core as impossible.

Next mathematicians attacked the problem on another side by reminding the geologists that the interior portions of the globe must support the outer portions, and that therefore the interior is subject to great pressure, as the following table by Professor R. S. Woodward shows:

Depth in miles.	Pressure, lbs., per square inch.
0 (Due to the atmosphere)	15
2	12,000
3	18,150
4	24,300
5	30,300
10	63,000
15	95,850
20	129,000
50	330,000
300	679,500
1000	10,080,000
2950	45,000,000

Iron work and metal and other substances melt at well-known temperatures under the ordinary conditions of daily life, but if we subject them to great pressure the melting points rise. Hence with regard to the rock of the interior when it is under great pressure it does not melt at 2200 degrees. We cannot say just at what temperature it fuses, but it is quite likely that the increase of temperature may never overcome the increase of pressure. It follows that the earth is solid clear through.

Local Reservoirs of Molten Rock.

But volcanoes must derive their lava from some source, and so we have come to believe in the existence of local reservoirs of molten rock underneath the volcanic districts.

The distribution of volcanoes is evidently along great lines of upheaval in the earth, and they and earthquakes are connected with fractures which penetrate the crust. Some force is, however, necessary to bring the lava to the surface. If the part of the earth which is one side of a great fracture sinks, it may force the lava in the underlying reservoirs to rise through the fissures, and we are reminded of the reports which state that the sea bottom has sunk off St. Vincent. Gravity is thus the propulsive force.

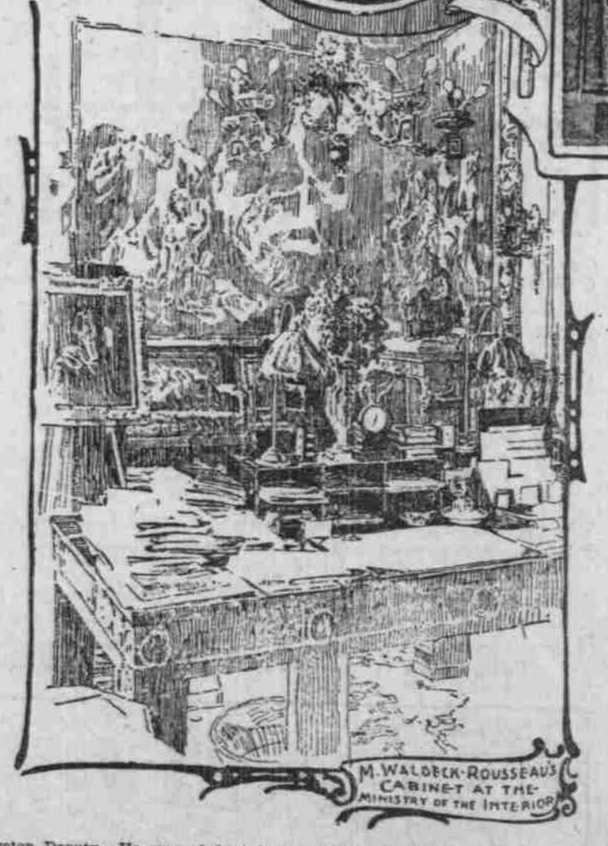
Others, however, lay emphasis on the vast amount of vapor held in the lava at such high pressure and temperature that it bursts with inconceivable violence and ascends in columns miles high in the air, when once it reaches the surface. They therefore trace the expulsion of the lava to its accumulation and final break for the upper air, bringing the lava with it in an irresistible, tumultuous rush. There are serious objections to the old belief that this vapor is sea water or any other form of surface water which percolates downward, but it is regarded by our most reliable observers as having been in the rocks from the time in which they first became constituents of the earth.

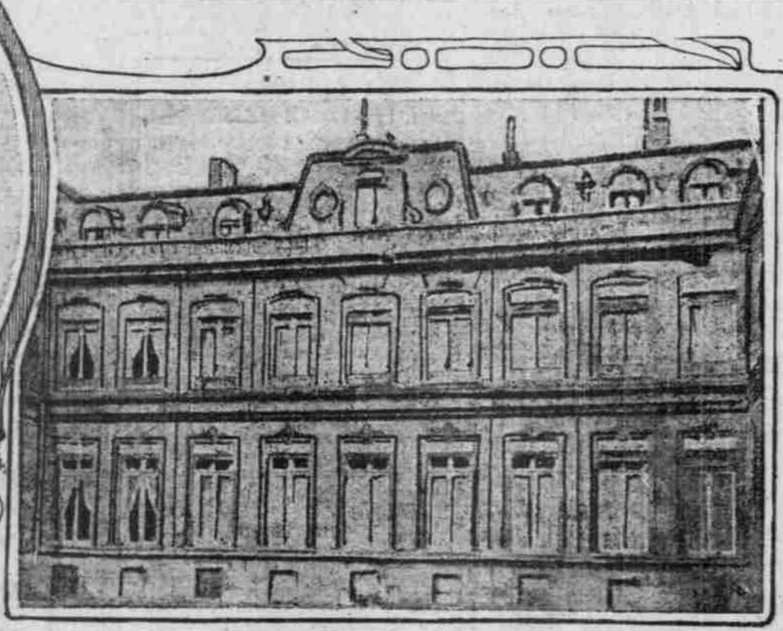
Volcanoes are shifted from time to time. As the geologists reckon time our Western States have not long been free from them. Mr. J. S. Diller, of the U. S. Geological Survey, has found one near Lassen's Peak, in California, with the trunks of trees still projecting through the beds of volcanic dust which killed them. Others have been described from Southern Utah in a remarkably fresh state of preservation, a result aided by the dry climate. Steam still issues from the crater of Mount Rainier, but outside of the Alaskan Islands we have no historic record of eruptions in the United States proper.

JAMES F. KEMP.

MOST PROMINENT FRENCHMAN SINCE GAMBETTA

WALDECK-ROUSSEAU, PRIME MINISTER, KNOWS HOW TO USE NAPOLEON'S SWORD. HIS FRIENDSHIP FOR ORGANIZED LABOR





MINISTRY OF THE INTERIOR. (WALDECK-ROUSSEAU'S APARTMENT CENTER OF THE FIRST FLOOR.)

M. WALDECK-ROUSSEAU'S COUNTRY HOUSE AT CORBEIL.

PIERRE Marie Waldeck-Rousseau, Prime Minister of France, whose administration was indorsed by 5,000,000 votes against 3,000,000, and who has just sent in his resignation, is easily the most remarkable Frenchman since Garbetta, and has become a world figure of power and significance.

Frenchmen, as a rule, do not understand him and a good third of them hate him intensely. Possessing pre-eminently the instincts that make for good order and diligent housekeeping, he has put the household of France to rights with a ruthlessness and thoroughness almost Napoleonic. Hence his enemies, and hence also his support from the business men and all conservative citizens of France. A dozen Prime Ministers have had the same opportunity, as the system of centralized administration exists today just as it was left by the first Napoleon. "Yes, the sword of Napoleon is there," said an official in explaining it to me, "but it took a swordsman to use it. Waldeck-Rousseau is a swordsman. That is the whole story."

For the past dozen years or so General Boulanger has represented to the world the typical Frenchman, picturesque, theatrical and voluble. Waldeck-Rousseau is none of these, and so he ruled nearly two years before his countrymen realized how great and how strong a man he was. Instead of another man on a black horse to lead France to new conquests here was a quiet gentleman in a black coat, who abhorred conquests and had a strong penchant for discovering talkative army officers. More than this, he does not look the typical Frenchman, being unusually tall, even by the English or American standard, stiff and angular in appearance, rather diffident in his manner; shunning notoriety and attention.

Once Had Artistic Ambitions.

Waldeck-Rousseau received his democracy from his father, who was one of the founders of the short-lived Second Republic, and his quiet determination from the people of Vendee, among whom he was born at Nantes, December 2, 1846. At one time he thought of being an artist and became quite proficient in water-color painting, but soon abandoned this except as a pastime, and studied law. After being admitted to the bar he became secretary to M. Dufret, then described as the first of French forensic orators. Then came the Franco-Prussian War. When Gambetta escaped from Paris in a balloon and called for his "levee en masse," Waldeck-Rousseau volunteered and received a Captain's commission, but never saw service.

Like Renan and many another great Frenchman, Waldeck-Rousseau began his real career at Rennes, the ancient capital of Brittany. He labored inconspicuously before the Court of Appeals, until a lucky chance, which he had the ability to grasp, made his fortune. A leading merchant, M. Dreyfus Gonzales, had before all the courts of France the same case, concerning maritime rights, in which the greater part of his large fortune was involved. His lawyer at Rennes retired, and with some misgiving the merchant sent the particulars of his case to Waldeck-Rousseau. The merchant kept stenographic reports of all his lawyer's speeches in the different courts. When he examined the pleas of his Rennes advocate he was amazed to find in them the clearest and most eloquent exposition of his case that had been made during the years of litigation. Shortly afterward, Waldeck-Rousseau, having interested himself in local politics, was chosen to represent Rennes in the Paris Chamber of Deputies, and Dreyfus Gonzales, to the amazement of the Paris bar, intrusted the legal management of all his affairs to the unknown Breton Deputy. He succeeded no less a man than M. Grevy, who had relinquished his law practice upon his election to the Presidency. The appointment made some stir in the legal and political world and gave Waldeck-Rousseau an immediate standing in the chamber.

Gambetta was then President of the Chamber and the undisputed leader of French Republicanism. He saw and admired qualities in Waldeck-Rousseau which he himself lacked, and with his usual impulsiveness almost at once admitted the young Deputy to his friendship and confidence. When, in 1880, Gambetta formed his "Grand Ministry," he gave Waldeck-Rousseau the Department of the Interior, the most desirable portfolio in the Cabinet, from the point of view of patronage and political influence. But the "Grand Ministry" came to an end in two months and its failure closed Gambetta's political career. Only Waldeck-Rousseau wrung from him a personal success. The reputation he gained as an administrator and civil reformer secured him the portfolio in Jules Ferry's Cabinet of 1882.

Earned $50,000 a Year at Law.

When the Ferry Cabinet fell, the longest in office except Waldeck-Rousseau's own, Waldeck retired from political life and devoted himself to law. He became leader of the Paris bar, with a professional income of about $50,000 a year. It remained for the political events growing out of the Dreyfus trial to bring him back into public life.

At this political period the Premiership of France was going begging. Cabinet after Cabinet had been overthrown and the country seemed ripe for revolution. Even inconsequential persons like Count Boni Castellane were for the moment exalted into prominence by their comical attempt to upset the government by smashing President Loubet's hat at a racecourse. The situation demanded a strong man, and by a happy inspiration the President called upon Waldeck-Rousseau. A change was almost immediately apparent. Instead of a Cabinet from one political group, Waldeck-Rousseau got other strong men wherever he could find them. Millerand, the Socialist, Gallifet, an irascible old martinet, with a silver stomach in place of the one shot away in the Mexican War, were among those chosen. Their first job was to get the Dreyfus case out of the way, which they did in a manner which by no means satisfied everybody, but with a finality that prevented further agitation. Then came two years of hard administrative work which makes no showing except in ultimate results.

One agitator after another was squelched. I remember being in Paris when Paul Deroulede was trying to make a General Boulanger of himself. In a rusty looking cab, so as to please the plain people, he was riding up and down the boulevards, receiving cheers and gaining a considerable following. Waldeck-Rousseau thought him over during the consumption of one cigarette and packed him over the frontier, where he still languishes. The administrative sword of Napoleon was coming into play. The next official heads to fall into the basket were those of high army officers who had been paying more attention to politics than to drill.

There was tremendous uproar, but nothing happened and the administrative machine ground on. The next adversary was a much more difficult one.

"Law of Religious Association."

Since Richelieu's day there has always been a section of the church party in France that has sought to mix religion and politics to the end of securing a priestly dictatorship. Here again the Napoleonic system was useful. When the great Corsican re-established Christianity in France he made an agreement or "concordat" with the Papacy by which no French bishops were to be appointed without the consent of the French government. All French administrations had been jealous of this prerogative and the Vatican authorities in turn had always tried to evade it. Feeling that its control over the parochial clergy was not sufficiently strong the Vatican encouraged the growth of religious orders in France which would be under the direct authority of Rome. These had grown very strong and Waldeck-Rousseau became convinced that they were meddling in politics with a view to overthrowing his government. As a result came the famous law of Religious Associations, which puts them all under the supervision of the government. Again there was great uproar and the associations have posed as martyrs before the world. But the French people have indorsed Waldeck-Rousseau's course in the matter by five votes to three.

But the man himself, aside from his determined use of the Napoleonic machine, accounts for his victory at the polls and the present stability of republican government in France. In most of his official life he is stiff and unbending and he holds his friends chiefly by never forgetting them nor deserting them. But occasionally he can unbend, and Count Munster, the German Ambassador, was heard to exclaim at a reception, "I wish my imperial master might know him." His real hold, however, is not with those who appear in drawing rooms, but with the workingmen of the nation. With the aspirations of organized labor he has always a strong and understanding sympathy.

The story is told that one day when he was first Minister of Interior, a number of carpenters called upon him who wished to form an association or guild for mutual benefit, but were unable to do so because they had no money. There was no public fund for the purpose, but Waldeck-Rousseau, struck with their plan, himself advanced the necessary amount. No papers were signed, no witnesses to the act were called, but the money was returned upon the day appointed. He was thus the father of the first workingman's association for mutual benefit organized in France, a movement that has now reached vast proportions. Waldeck-Rousseau's connection with it has given him a hold with the masses which his political opponents have never been able to shake.

Cartoonists make Waldeck-Rousseau's head long and narrow, with a heavy under jaw and a generally wooden expression. His enemies describe "the hated Waldeck" as being metallically hard and unsympathetic. "He is a man who does not talk" they say, and a Frenchman who is not voluble is sure to be imperfectly understood by his fellow-countrymen. Of his colleagues in the cabinet he asks advice and then always follows his own ideas.

He is a great cigarette smoker and when there is a great question on, he obscures himself in a cloud of smoke until he has thought it out. Once decided he retires into an upstairs room, which is arranged like a studio, and amuses himself with water color painting, apparently as much absorbed in the little canvas before him as he was a few moments before in the destinies of a nation. When he has time for longer recreation he goes fishing. His country house on the Seine above Paris almost overlooks the river. His principal outdoor companion is Tcho, a big Chinese dog, whom his master describes as "an excellent keeper of political secrets."

Of the Minister's private life the world knows little except that it is blameless—something not always possible to say of French public men in the past and now part of the better order of things in French politics. Madame Waldeck-Rousseau was a widow when he married her 20 years ago. They have no children, else he might have been more like other Frenchmen, who are young again with their sons.

JOHN VANDERCOOK.