the separate pieces of clocks and watches are now produced in a high state of perfection; but it was contended, that horology, as a science, had declined since the days of Hooke, Bernouilli, Sully, Graham, Harrison, Camus, Mudge, Ellicot, the two Arnolds, Earnshaw, Le Roy, Berthoud and others, whose splendid talents and scientific attainments were all devoted to the elevation of the art of constructing time-keepers. Among these Dr. Hooke appears to have been the first to bring the force of acute reasoning and pure mechanical genius to bear upon the practice of the art, and his experiments upon the pendulum and the application of the balance-spring —which latter unquestionably laid the foundation of the chronometric art. It is evident that he partially raised the veil which concealed the laws of the isochronism of the spiral spring; as is demonstrated by his expression "*ut tensio sic vis*,"—and it is extraordinary that so plain a hint was not immediately seized on by the able men who succeeded him.—Arnold appears to have been the first who really practically comprehended the subject; and in the course of his researches he invented the cylindrical spring and compensation-balance, which formed the commencement of a new era in the science. The merit of the discovery of the isochronism in France was contested by Le Roy and Berthoud. Bernouilli noticed, in a paper read to the *Académie* in 1747, the fact of the loss of elastic force in balance-springs, from exposure to heat; and the experiments of Berthoud demonstrated that in passing from 32° to 92° Fahrenheit the loss per diem was 6 minutes 33 seconds. The paper then considered generally and technically the subject of the isochronism of the balance-spring; enunciating isochronism to be an inherent property of the balance-spring, depending entirely upon the ratio of the spring's tension, following the proportion of the arcs of inflexion. A balance-spring therefore, having the progression required by the law of isochronism, will preserve that property, whether it be applied to a balance making quick or slow vibrations. The elastic force of balance-springs was considered as a constant; because the action is by a number of consecutive impulses following each other in such rapid succession as to constitute an uninterrupted and continuous force. This is shown in considering the accelerated and retarded motion of the balance, when, by following it through an entire arc of vibration, it will be seen that if the balance be moved over a given number of degrees, the spring will be wound into a certain tension, and has acquired a certain elastic force due to the angles over which it is inflected. This elastic force being then transferred to the balance, it will be exerted in overcoming its inertia, and at the expiration of the first period, will have communicated a slight motion to it. During the next period, its state will be that of comparative and not absolute inertia (for it *decreases* as the motion *increases*); whence it follows, that as the spring's force is exerted against a body in motion instead of at rest, it will necessarily accelerate progressively the motion the balance had previously acquired, until the spring arrives at the point of quiescence—where, having lost all its elasticity, it ceases further to urge the balance, and a new relation of power and resistance takes place. The spring's force being transferred to the balance, it assumes a new character,—has acquired sufficient momentum to carry it through the second half of the vibration, and to inflect the spring over an angle equal to that first passed over, and to give it the requisite tension to commence a new vibration; particularly as during the second half of the vibration the spring has so little tension, that its force retards but slightly the motion of the balance. After reasoning on this position, illustrated by numerical examples, the author proceeded to describe the helical and the flat coiled springs which are used in chronometers and watches, and the manner of regulating their action so as to take advantage of the isochronism; instancing the advantages to be derived from the innate power possessed by an isochronal spring of resisting the influences which cause a change of rate—such as change of position, increased friction from dirt, or the viscidity of the oil at low temperatures. This was illustrated by an example of three balls falling in equal times through spaces regulated by the densities of the medium—viz. in vacuo, in air, and in water; wherein they traverse spaces equal to the squares of the times. So, it was argued, it was with increased friction in watch-work; for the elastic forces of the balance-spring being constantly proportional to the angle of inflexion whatever was the amount of friction, the law of isochronism remained unchanged, and friction was only an adventitious circumstance, which affects the extent of the arc of vibration, but not the time of its description.

Royal Institution.—*April* 30.—W. R. Hamilton, Esq., in the chair.—'On the Age of the Volcanoes of Auvergne as determined by the Remains of successive Groups of Land Quadrupeds,' by C. Lyell, Esq. The region of extinct volcanoes of Auvergne derives its peculiar interest from the circumstance of its never having been submerged beneath the sea during a period in which its geological and geographical structure, and the animals and plants by which it has been inhabited, have undergone a great succession of changes. In the rest of Europe generally the volcanic rocks have either been originally of submarine origin, or the surface since they were produced has suffered so much denudation by the action of the waves of the ocean as to make it impossible for us to ascertain the form and manner in which the eruptions took place, or the relative position which the igneous formations held at first to the hills, plains, and valleys then existing. After describing the several classes of rocks in Auvergne—the granite, the eocene freshwater, and the older and modern volcanic, each depicted by different colours in an extensive landscape enlarged from a view of the valley of Chambon (Puy de Dome) by Mr. P. Scrope,—Mr. Lyell said he should dwell chiefly on the antiquity to be ascribed to the Puy de Tartaret, a type of one of the most modern cones of eruption in Central France. The comparatively recent origin of this conical hill of scoriæ, with its crater at the summit, is proved by its standing at the bottom of a deep valley excavated through the alternating beds of pumice, trachyte, and basalt, belonging to the more ancient volcano of Mont Dor, and partly through the subjacent and fundamental granite. It is farther confirmed by the course of a powerful current of lava; which, proceeding from the base of the cone, flows thirteen miles down the channel of the River Couze, stopping at the town of Nechers, near Issoire. The lava occupies the ancient river-bed, and is observed to contract in its dimensions in the narrow gorges, where it also gains in height, like the water of a river flowing through the arch of a bridge; and to expand again where the valley opens, where it spreads into a broad sheet having a level surface. It also flows up the channels of tributary streams till it attains a level corresponding with the top of the lava at the point of junction of the tributary with the main valley. But although these appearances prove that the lava has flowed as it would now do if it were remelted and made again to descend the same channel, it nevertheless bears in some part of its course the marks of considerable age.

Before considering these, Mr. Lyell entered into a short digression to refute the doctrine of the mediæval origin of the volcanoes near Clermont, advanced by a writer in the *Quarterly Review* for Oct. 1844 (p. 295), where it is pretended that Sidonius Apollinaris, Bishop of Clermont, who flourished at the close of the fifth century, has borne explicit testimony to "the volcanic eruption, the crumbling of the cones, and the heaping up of the showers of ashes and scoria cast forth amidst their fires." The passages relied on occur in a letter from Sidonius to his contemporary, Mamertus, Bishop of Vienne, in Dauphiny, written when Auvergne was threatened with a fresh irruption of the Goths; to avert which danger the Bishop proposes to adopt certain forms of prayer (rogations or litanies), which Mamertus had already introduced on the occasion of some "prodigies" which had happened in Dauphiny sixteen years before. In alluding to these phenomena, Sidonius says that "the walls of the city of Vienne were shaken by frequent earthquakes, many fires broke out, and mounds of ashes were heaped up over the fallen copings of the walls." "Nam modo scenæ mœnium publicorum crebris terræ motibus concutiebantur, nunc ignes sæpe flammati caducas culminum cristas, superjecto favillarum monte tumulabant." Deer also took refuge in the forum, and the people fled; all but the Bishop, who had a right to reckon on divine protection, because, as Sidonius reminds him, on a former occasion, the flames at his approach had miraculously receded out of reverence to his holy person. At the time of the earthquake he (Mamertus) had told his people that their repentant tears would extinguish the fires sooner than rivers of water, and the steadfastness of their faith would cause the rocking of the ground to cease. Sidonius finishes with asking the Bishop of Vienne to send him some relics to make all secure. The style of the whole epistle is so faulty, ambitious, and poetical, as to make it difficult to know the exact value of the expressions, and dangerous to found upon them any philosophical argument about natural events. There is not a word about Auvergne, but simply an allusion to the shocks which appear to have thrown down buildings and caused (as usual in such cases where roofs fall in) great conflagrations and heaps of cinders. The terror of the wild animals when the earth rocks and their sensitiveness to the slightest movements are well known. Although the epistle proves Sidonius to have had a fair share of the credulity of his age, both in respect to miracles wrought in favour of a contemporary saint and the efficacy of relics, it would be unfair to charge him with a belief in the occurrence of a volcanic eruption at or near the site of the city of Vienne, which the investigation of the ablest government surveyors, to whom the construction of a geological map of France has been intrusted, has entirely disproved. There are, in fact, no monuments of volcanoes, ancient or modern, in Dauphiny; and if there had been they would not throw light on the date of eruptions in Auvergne.

But to return to the lava-stream of the Puy de Tartaret before alluded to—what geological antiquity can we assign to it? In one of the gorges the entire mass of solid basalt has been swept away by the torrent, so that the former continuity of the stony current is interrupted for several hundred yards, at a point about midway between its efflux from the cone and its termination. This implies a long period of excavation. In another place, about one mile and a half from St. Nectaire, an old Roman bridge, still passable, having two arches, each fourteen feet wide, spans a deep ravine, cut by the Couze through the middle of the lava which is here of columnar structure. The bridge is supposed by French architects and antiquaries to be of the date of about the fifth century; yet the springing of the arches proves that when it was erected the ravine was of the same width as now. Nevertheless, while signs of denudation such as these attest the vast amount of removal of hard rock since the lava flowed and was consolidated, the contemporary cone of loose, incoherent scoriæ has stood in its exposed position at the very bottom of a valley, entire and uninjured, the rain-water being instantly absorbed by the porous mass; and no rill being allowed to collect on its flanks. It is clear that if any flood of water had passed over Auvergne, if any inundation had raised the Lake of Chambon thirty or forty feet, it must have carried away the perishable cone. The lake alluded to owes its origin to the damming up of the Couze by the volcano and by landslips which accompanied the eruption.

But the most conclusive evidence, according to Mr. Lyell, of the remoteness of the period at which the cone and lava of Tartaret originated has yet to be set forth, and has only been distinctly brought to light since he revisited Nechers in 1843, when the Abbé Croizet pointed out to him a locality near the lower extremity of the great current, where fossil bones of extinct animals had been discovered in a meadow, between the base of the lava and the channel of the Couze, now ten feet lower in level than the lava. In company with Mr. Bravard, Mr. Lyell explored the spot; and they convinced themselves that the bone-deposit passed under the lava, which here forms a mass thirty feet thick. Subsequent investigations not only confirm this view, but have enabled Mr. Bravard to obtain from beneath the stony current a considerable number of additional osseous remains, referable to the genera Equus, Sus, Tarandus, Cervus, Canis, Felis, Martes, Putorius, Sorex, Talpa, Arvicola, Spermophilus, Lagomys, Lepus, and, according to Mr. Waterhouse, Cricetus or hamster, and others, besides the remains of a frog, lizard, and snake, and the bones of several birds. Mr. Owen has examined some of these remains for Mr. Lyell, and recognizes among them the *Equus fossilis* and *Tarandus*