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Owning the Center of the Earth

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OWNING THE CENTER OF THE EARTH

John G. Sprankling^{*}

How far below the earth's surface do property rights extend? The conventional wisdom is that a landowner holds title to everything between the surface and the center of the earth. This Article is the first legal scholarship to challenge the traditional view. It demonstrates that the "center of the earth" theory is poetic hyperbole, not binding law. Broadly speaking, the deeper the disputed region, the less likely courts are to recognize the surface owner's title. The emergence of new technologies for use of the deep subsurface—such as heat mining and carbon sequestration, both of which may help mitigate global climate change—requires that we develop a new model of subsurface ownership. Accordingly, this Article proposes and evaluates four alternative approaches to subsurface property rights. The preferred model would recognize the surface owner's title for only 1000 feet downward. If adopted, this approach would eliminate over 99 percent of the supposed real property ownership in the United States.

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INTRODUCTION

Company A plans to install a fiber optic cable for electronic data that will pass one hundred feet below the land surface owned by B. C seeks to create clean energy through heat mining, using naturally hot rock formations three miles below land partly owned by D corporation. E hopes to mitigate global climate change by storing recaptured carbon five miles beneath the land surface owned by F. Suppose that surface owners B, D, and F object. These hypothetical situations all present the same question: How deep do property rights extend?

For decades, the American legal system has answered this question with the solemn assurance that a landowner's title extends to everything between the land surface and the center of the planet. This approach is reflected in the Latin maxim *cujus est solum, ejus est usque ad coelum et ad inferos*, usually translated as meaning that the rights of the surface owner extend upward to the heavens (*ad coelum*) and downward to the center of

the earth (*ad inferos*). Thus, each landowner in the United States supposedly owns a slender column of rock, soil, and other matter stretching downward over 3900 miles from the surface to a theoretical point in the middle of the earth.¹

Today, we are poised on the brink of a landmark in human exploration: Scientists are now planning to drill through the earth's crust to reach the next layer below, the mantle.² When completed, this project will mark the first time that humans have ever penetrated below the crust. In addition, scientists are now examining potential new uses for the deep crust, such as carbon sequestration and heat mining, both of which may help to alleviate global climate change.³ Accordingly, it is time to reexamine the "center of the earth" theory. Just as the *ad coelum* doctrine crumbled with the invention of the airplane, the center of the earth theory is destined to collapse with the advent of new subsurface technology.

This Article demonstrates that the center of the earth approach is mere poetic hyperbole, not law. Indeed, the law of subsurface ownership is so confused that it is impossible to know how deep property rights extend. Accordingly, this Article proposes a new subsurface ownership model that strikes an appropriate balance between the legitimate interests of the surface owner and the needs of society in general.

Part I explores the historical evolution of the center of the earth theory. It is not an ancient common law doctrine sanctified by the wisdom of ages. Rather, when first announced by William Blackstone in the eighteenth century, it was inconsistent with prior English law. However, due to Blackstone's influence, it slowly spread to the United States during the nineteenth century, was repeated uncritically by American courts and treatise writers, and became the generally accepted view.

Part II examines the geology of the earth's interior in order to provide a scientific foundation for the balance of the Article. Blackstone's implicit belief that humans could access the deep subsurface reflects the primitive

1. There is surprisingly little scholarship concerning the downward extent of a surface owner's property rights as a general matter. The subject is discussed briefly in Stuart S. Ball, *The Vertical Extent of Ownership in Land*, 76 U. PA. L. REV. 631, 684–89 (1928), although the article mainly concerns rights in airspace. Ball reaches the "working hypothesis" that "the space lying beneath the surface . . . can be owned," but does not discuss the depth of ownership. *Id.* at 689; see also Haim Sandberg, *Three-Dimensional Partition and Registration of Subsurface Land Space*, 37 ISR. L. REV. 119 (2003) (discussing Israeli law concerning subsurface ownership). For a discussion of the downward extent of national sovereignty, see D.S. Avery, *In Anticipation of Subterrestrial Delimitation*, 6 HASTINGS INT'L & COMP. L. REV. 37 (1982).

2. Benoit Hldefonse et al., *Mission Moho Workshop: Drilling Through the Oceanic Crust to the Mantle*, 4 SCI. DRILLING 11, 11 (2007).

3. See *infra* text accompanying notes 321–333.

geological knowledge of his era. Based on twentieth century research, we now understand that the vast majority of the interior is inaccessible to humans. For example, it would be difficult for humans to survive even two miles below the surface without special equipment.

Part III analyzes appellate decisions in order to demonstrate that the center of the earth theory has never been binding law. In cases involving underground uses within one hundred feet or so of the surface—such as disputes about building foundations or tree roots—courts have routinely recognized the surface owner's title. Beyond this point, however, the law is inconsistent at best. Broadly speaking, the deeper the disputed region, the less likely courts are to rely on the center of the earth theory. Moreover, the deepest subsurface dispute ever litigated in the United States involved a region less than two miles deep—about one-twentieth of 1 percent of the distance from the surface to the earth's center.⁴ Any suggestion that the law recognizes property rights below this point is no more than dicta.

Finally, Part IV applies utilitarian criteria to craft a new model of subsurface ownership. It first rejects the quaint but bizarre notion that ownership extends below the earth's crust. It then focuses on the more serious question of how deeply ownership should extend within the crust by evaluating four alternative models. Ultimately, it proposes that the surface owner's title should extend downward for only 1000 feet, subject to special exceptions for mineral rights. The subsurface beneath this point would be owned by the federal government. By rejecting center of the earth rhetoric, this model would eliminate over 99 percent of the theoretical real property ownership in the United States, as measured by volume.⁵

I. EVOLUTION OF THE CENTER OF THE EARTH THEORY

A. The Common Law Foundation

The theory that American law recognizes ownership to the center of the earth can be traced back to 1766, when William Blackstone boldly proclaimed the doctrine in his famous treatise *Commentaries on the Laws*

4. See *Nunez v. Wainoco Oil & Gas Co.*, 488 So. 2d 955 (La. 1986).

5. The earth's continental crust is on average twenty-two to twenty-five miles thick. FREDERICK K. LUTGENS & EDWARD J. TARBUCK, *ESSENTIALS OF GEOLOGY* 19 (9th ed. 2006). Yet the crust accounts for only 1 percent of the earth's volume. NATALIE ANGIER, *THE CANON: A WHIRLIGIG TOUR OF THE BEAUTIFUL BASICS OF SCIENCE* 221 (2007). Assuming that the surface owner's rights extend downward 1000 feet, he owns less than 1 percent of the volume of the crust—less than 0.01 percent of the total volume of the earth.

of England.⁶ It was not a principle of Roman law⁷—despite the Latin phrasing of the maxim—nor was the theory recognized in early common law.⁸ Rather, it is best viewed as hyperbole invented by Blackstone, without any prior foundation in English law. Measured against the yardstick of common law history, it is a comparatively modern creation.

Blissfully ignorant of subsurface geology, English and American courts repeated this center of the earth dictum over the ensuing decades, often in cases where subsurface rights were not even in dispute. Authors of legal treatises and legal dictionaries similarly adopted the dictum, using it broadly to help define the meaning of “land,” or to explain the scope of property rights that were conveyed by a deed. By the end of the nineteenth century, frequent repetition had transformed Blackstone’s naked assertion into a supposed rule of American law.

1. Subsurface Ownership in Early English Common Law

Before Blackstone’s intervention, the English approach to subsurface ownership was both narrow and practical. In effect, the law recognized that a landowner had title only to the region immediately underneath the surface, which he could physically use for a productive purpose (the near-surface standard). By definition, this near-surface standard meant that ownership extended only a short distance downward, depending on the use involved. For example, in a 1523 decision involving a landowner’s rights in airspace, one court noted that the owner “will have the land in which the tree grows, for the tree has its being through the earth and air, and therefore all the earth in which it grows in depth, and the air it needs in height belong to him to whom the tree belongs.”⁹ The implication is that the surface owner owned only as far downward as necessary to accommodate the roots of his tree.

6. WILLIAM BLACKSTONE, 2 COMMENTARIES *18.

7. The concept that the surface owner’s rights extend to the center of the earth stems from Cinus of Pistoia, an Italian scholar from the fourteenth century. See JEAN BRISSAUD, HISTORY OF FRENCH PRIVATE LAW 283 (Rapelje Howell trans., Little, Brown & Co. 1912).

8. See *infra* Part I.A.1. In contrast, Scottish law apparently recognized that the surface owner’s title extended to the center of the earth as early as the late 1600s. See, e.g., 1 THOMAS CRAIG, THE JUS FUEDALE 525 (James Avon Clyde trans., William Hodge & Co. 1934) (1655) (describing subsurface coal ownership as extending *inter coelum et inferos*); JAMES DALRYMPLE, INSTITUTIONS OF THE LAW OF SCOTLAND 275 (1681) (noting that a conveyance of land transfers title *a coelo ad centrum*, that is, from the heavens to the center of the earth).

9. Y.B. 14 Hen. 8, fol. 1, pl. 1 (1523), as translated in Edward C. Sweeney, *Adjusting the Conflicting Interests of Landowner and Aviator in Anglo-American Law*, 3 J. AIR L. 329, 357 (1932).

Another example comes from the *Case of Mines*¹⁰ in 1568, where the court had to define the scope of the Crown's admitted right to mines of gold and silver, when the gold and silver were located on private lands and mixed with other metals. The court concluded that "if the ore or mine in the soil of a subject be of copper, tin, lead, or iron, in which there is no gold or silver, in this case the proprietor of the soil shall have the ore or mine, and not the Crown."¹¹ This decision similarly reflects a pragmatic focus; the court adjudicated rights to near-surface resources that were actually subject to human exploitation, without discussing any deeper subsurface rights.

Early English legal treatises reflected the same pragmatic view of subsurface ownership: None suggested that a landowner's rights extended to the center of the earth.¹² For instance, in 1628 Edward Coke grandly explained in *The First Part of the Institutes of the Laws of England*¹³ that the rights of the surface owner stretched "a great extent upwards . . . even up to heaven; for *cujus est solum ejus est usque ad coelum*, as is holden."¹⁴ In contrast, Coke defined "land" mainly in terms of surface rights: "any ground, soile, or earth whatsoever; as meadowes, pastures, woods, moores, waters, marishes, furses, and heath."¹⁵ Coke said little about subsurface ownership, aside from observing that the land owned by a property owner included items such as building foundations,¹⁶ minerals like "gold, silver, brasse, iron, tynne,

10. R. v. Earl of Northumberland (*Case of Mines*), (1568) 1 Plowden 310, 75 Eng. Rep. 472.

11. *Id.* at 510–11.

12. See, e.g., HENRY FINCH, LAW, OR A DISCOURSE THEREOF, IN FOUR BOOKS 131, 132 (W.S. Hein 1992) (1678) (loosely following Coke's definition of "land," but noting that the king owns all mines of gold and silver). However, most sixteenth- and seventeenth-century English sources do not discuss subsurface ownership at all. See, e.g., WILLIAM NOY, A TREATISE OF THE PRINCIPALL GROUNDS AND MAXIMES OF THE LAWES OF THE KINGDOME (London, R.H. 1641); JOHN RASTELL, AN EXPOSITION OF CERTAINE DIFFICULT AND OBSCURE WORDS, TERMES OF THE LAWES OF THIS REALME (n.p., Richard, ToHelli 1579); WILLIAM SHEPPARD, AN EPITOME OF ALL THE COMMON AND STATUTE LAWS OF THIS NATION (London, W. Lee 1656); EDMOND WINGATE, MAXIMES OF REASON: OR, THE REASON OF THE COMMON LAW OF ENGLAND (London, R. & W.L. 1658).

13. EDWARD COKE, THE FIRST PART OF THE INSTITUTES OF THE LAWS OF ENGLAND (Garland Publ'g 1979) (1628).

14. *Id.* at 4.a. Coke apparently borrowed this phrase from civil law scholars, where it can be traced back to Accursius, a glossator whose commentaries on Roman law were written in the thirteenth century. See JOHN COBB COOPER, EXPLORATIONS IN AEROSPACE LAW 74–75 (1968). For a comprehensive history of the *cujus est solum* maxim as applied to airspace, see *id.* at 54–102. In fact, although the maxim was "not part of Roman written law . . . it is apparent that it must have sprung originally from principles of Roman law—though stated in a non-Roman manner." *Id.* at 84–85; see also Andrea B. Carroll, *Examining a Comparative Law Myth: Two Hundred Years of Riparian Misconception*, 80 TUL. L. REV. 901, 907–19 (2006) (discussing early history of the maxim as applied to water law).

15. 1 COKE, *supra* note 13, at 4.a.

16. *Id.*

leade, and other metals,”¹⁷ and salt pits.¹⁸ Two themes link these subsurface uses: (1) Each is located near the surface; and (2) each is a productive economic use. Thus, while the surface owner’s airspace rights theoretically extended to heaven (as medieval civil law scholars suggested),¹⁹ his subsurface rights—still governed by the near-surface standard—were remarkably shallow.²⁰

This dichotomy between a landowner’s supposedly infinite airspace rights and limited subsurface rights dominated English law for over a century after the publication of Coke’s treatise. A handful of cases during this period recited the *ad coelum* maxim in airspace disputes, though, of course, always in dictum.²¹ And subsequent treatises routinely cited Coke for the proposition that airspace rights extended *ad coelum*.²² But when subsurface rights were discussed during this period—which was rare—judges and scholars implicitly assumed that the rights of the surface owner extended downward only within the near-surface zone where he actually used the land.²³ For instance, the 1757 decision of *Goodtitle v. Alker*²⁴ examined the rights of a landowner whose property was burdened by a public highway. Observing that the owner still “has a right to the soil,” the court discussed the uses to which the owner could devote the land, consistent with the highway, such as “mines running under it” or “by carrying water in pipes under the streets.”²⁵

2. Blackstone’s Absolutist Approach to Subsurface Ownership

Blackstone initially seems to have endorsed the near-surface standard found in the early common law. For example, in *An Analysis of the Laws*

17. *Id.*

18. *Id.* at 4.b.

19. See COOPER, *supra* note 14.

20. A similar approach is found in WILLIAM SHEPPARD, *THE TOUCH-STONE OF COMMON ASSURANCES* 90 (London, M.F. 1648). Largely relying on Coke, Sheppard observed that “[b]y the grant of the land, or ground it selfe, all that is *supra*, as houses, trees, and the like is granted, for *Cujus ejus est solum est usque ad coelum*, also all that is *infra*, as Mines, earth, clay, quarres, and the like.” *Id.* All of Sheppard’s examples of subsurface ownership concern a productive economic use in the near-surface zone.

21. See, e.g., *Thrustout v. Grey*, (1739) 2 Mod. 282, 87 Eng. Rep. 1242, 1244, 1245; *Ryder v. Bentham*, (1750) 1 Ves. Sen. 543, 27 Eng. Rep. 1194, 1194; *Pawson v. Scott*, (1755) Sayer 176, 96 Eng. Rep. 843, 843–44; *Cox v. Matthews*, (1684) 1 Ventris 239, 86 Eng. Rep. 160, 160.

22. See, e.g., JOHN COWELL, *THE INTERPRETER OF WORDS* (1701); THOMAS WOOD, *AN INSTITUTE OF THE LAWS OF ENGLAND* 116 n.b. (photo reprint 1979) (3d ed. 1724).

23. See, e.g., WOOD, *supra* note 22, at 306 (discussing rights to “dig for gravel, lime, clay” and to “mines of metal, coal”).

24. (1757) 1 Keny. 427, 96 Eng. Rep. 1044.

25. *Id.* at 1048.

of England,²⁶ published in 1756, he defined “Corporeal Hereditaments” to “include not only the Face of the Earth, but every other Object of Sense adjoining thereto, and subsisting either above or beneath it.”²⁷ Under this formulation, the rights of the surface owner extended only to an “object of sense”—such as a building foundation, a well, or a mine—that “adjoined” the surface.

A decade later, however, Blackstone’s influential *Commentaries on the Laws of England* advocated the revolutionary view that ownership under English law extended from the surface to the center of the earth. In defining the term “land,” Blackstone first echoed Coke, citing *cujus es solum, ejus est usque ad coelum* as “the maxim of the law” for ownership of airspace.²⁸ After opining that ownership extended “an indefinite extent, upwards as well as downwards,” Blackstone then added this phrase:

[A]nd, downwards, whatever is in a direct line between the surface of any land and the center of the earth, belongs to the owner of the surface; as is every day’s experience in the mining countries. So that the word “land” includes not only the face of the earth, but every thing under it, or over it.²⁹

Interestingly, the only citations that Blackstone offered for his definition were to Coke, even though this formulation contradicts Coke’s near-surface approach to subsurface ownership.

The most likely source for Blackstone’s center of the earth theory is Samuel Pufendorf, a leading German theorist. It is widely accepted that Pufendorf helped to shape the approach to property law that Blackstone adopted in the *Commentaries*.³⁰ Consistent with views advanced by earlier European scholars in the civil law tradition,³¹ Pufendorf had previously embraced the center of the earth doctrine in his *Elementorum Jurisprudentiae*

26. WILLIAM BLACKSTONE, AN ANALYSIS OF THE LAWS OF ENGLAND (Oxford, Clarendon 1756).

27. *Id.* at 32.

28. 2 BLACKSTONE, *supra* note 6, at *18.

29. *Id.*

30. See, e.g., Susanna L. Blumenthal, *The Deviance of the Will: Policing the Bounds of Testamentary Freedom in Nineteenth-Century America*, 119 HARV. L. REV. 959, 968 (2006); Adam Mossoff, *What Is Property? Putting the Pieces Back Together*, 45 ARIZ. L. REV. 371, 399–400 (2003). Indeed, William Blackstone sometimes cited to Samuel Pufendorf to support his interpretation of English property law. See, e.g., 2 BLACKSTONE, *supra* note 6, at *8.

31. The center of the earth theory originated in civil law scholarship from the fourteenth century. See BRISSAUD, *supra* note 7, at 283; LUIGI MIRAGLIA, COMPARATIVE LEGAL PHILOSOPHY 474 (John Lisle trans., Macmillan Co. 1912) (1873). Luigi Miraglia commented that the doctrine was “a hyperbole . . . [which has] no foundation in the sources of Roman law.” *Id.* at 475.

Universalis Libri Duo, published in 1661.³² In explaining the meaning of a “corporeal thing,” Pufendorf observed:

Proper space is that which perpendicularly overhangs or lies beneath the area of the possessor, upwards as well as downwards. Now since the areas of the terrestrial globe possess a spherical convexity, any one understands that perpendicular lines meet below in the centre of the earth . . . [Accordingly,] I might lawfully dig down until I reached only as far as the centre of the earth, even if it were possible to go farther.³³

Here we see the core of Blackstone’s later position: The boundary of subsurface property is defined by lines that connect the surface parcel to the center of the earth.

Blackstone’s acceptance of this sweeping view of subsurface property rights is consistent with his natural law approach to property.³⁴ For Blackstone, property was a gift from God, not the product of human decision. Citing Genesis, he explained that “the all-bountiful creator” gave humans “dominion over all the earth.”³⁵ Accordingly, “[t]he earth therefore, and all things therein, are the general property of all mankind . . . from the immediate gift of the creator.”³⁶ From that starting point, “the principles of universal law” vested title in the first person to occupy a parcel of land.³⁷ Just as the God-given scope of human dominion extended to “all the earth,” the dominion of the surface owner must logically include all of the subsurface—down to the center of the earth.

Yet Blackstone’s religiously inspired standard was internally inconsistent. He partially justified³⁸ the center of the earth theory by stating that it

32. 2 SAMUEL PUFENDORF, *ELEMENTORUM JURISPRUDENTIAE UNIVERSALIS LIBRI DUO* 52 (William Abbott Oldfather trans., Clarendon Press 1931) (1661). In the original Latin passage, Pufendorf discussed ownership downward *in centro terrae* and *ad centrum terrae*. This usage may well be the source of the early Scottish theory, as expressed by James Dalrymple in 1681, that ownership extends downward *ad centrum*. See DALRYMPLE, *supra* note 8, at 385.

33. 2 PUFENDORF, *supra* note 32, at 52.

34. For discussion of Blackstone’s approach to property in general, see Albert W. Alschuler, *Rediscovering Blackstone*, 145 U. PA. L. REV. 1 (1996), and Robert P. Burns, *Blackstone’s Theory of the “Absolute” Rights of Property*, 54 U. CIN. L. REV. 67 (1985).

35. 2 BLACKSTONE, *supra* note 6, at *2 (quoting Genesis 1:28).

36. *Id.* at *3.

37. *Id.* at *9.

38. Consistent with natural law theory, Blackstone was largely content to proclaim his new theory of subsurface ownership without demonstrating that it was supported by logic or policy. See *id.* at *2. Indeed, earlier in the *Commentaries*, he noted that “we rest satisfied with the decision of the laws in our favour, without examining the reason or authority upon which those laws have been built.” *Id.*

reflected “every day’s experience in the mining countries.”³⁹ But this was obviously untrue; early mines rarely reached a depth of 1000 feet, much less the center of the earth, so this rule was not consistent with “experience.” In fact, as the *Case of Mines* had indicated two centuries earlier, English law had long held that the surface owner owned the mines underneath his land.⁴⁰ Thus, “every day’s practical experience” in mining regions would have endorsed the traditional near-surface approach to subsurface ownership, not Blackstone’s new absolutism.

In the ensuing decades, Blackstone’s center of the earth theory appeared in only a handful of English cases⁴¹ and treatises.⁴² But it came to be expressed in two different formulations. Some authorities simply quoted the English text from the *Commentaries*,⁴³ as noted above. Others expressed the concept in Latin, most commonly by amending Coke’s *ad coelum* maxim to add *et ad inferos* (meaning “to the center of the earth”)⁴⁴ at the end, providing a pleasing symmetry that the original lacked.⁴⁵ This *ad inferos* phrasing had long been used in civil law scholarship.⁴⁶ Thus,

39. *Id.* at *18.

40. See *R. v. Earl of Northumberland (Case of Mines)*, (1568) 1 Plowden 310, 75 Eng. Rep. 472, 510–11; see also *supra* text accompanying notes 10–11. However, there were exceptions to this rule. For example, miners in Cornwall were allowed to develop tin mines on certain lands without the owners’ consent. See, e.g., *Rogers v. Brenton*, (1847) 10 Q.B. 26, 116 Eng. Rep. 10, 10 (discussing the history of this custom). Similarly, as Jeremy Bentham observed, under some circumstances if a vein of ore was found on one parcel, the owner was entitled to mine all of the vein even if it extended into land owned by another. JEREMY BENTHAM, *THE THEORY OF LEGISLATION* 164 (1931) (1802).

41. See, e.g., *Doe v. Burt*, (1787) 1 T.R. 701, 99 Eng. Rep. 1330, 1330 (noting the argument of counsel that the maxim *cujus est solum, ejus est usque ad caelum et ad inferos* supported the defendant’s claim of title to the cellar). Interestingly, the theory does not appear in the leading legal dictionaries of the era. See 2 T. CUNNINGHAM, *A NEW AND COMPLETE LAW DICTIONARY* (n.p., 1789) (defining “land” by citing to Coke, with no mention of subsurface ownership); GILES JACOB, *A NEW LAW DICTIONARY* (n.p., 1750) (same).

42. See, e.g., 1 WILLIAM CRUISE, *A DIGEST OF THE LAW OF ENGLAND RESPECTING REAL PROPERTY* 3 (London, A. Strahan 1804) (explaining that ownership extends downward in a “direct line between the surface and the centre of the earth”).

43. See, e.g., *id.*

44. In Latin, *inferus* literally refers to the “lower world” or the place of the dead—what modern theologians would call “hell.” CASSELL’S *LATIN DICTIONARY* 303–04 (D.P. Simpson ed., 5th ed. 1977). However, legal scholars have routinely translated *et ad inferos* to mean the center of the earth.

45. See, e.g., *Doe*, 99 Eng. Rep. 1330. Over time, several variants of this phrase emerged, all connoting ownership to the center of the earth. See, e.g., *Parrot Silver & Copper Co. v. Heinze*, 64 P. 326, 329 (Mont. 1901) (*usque ad coelum et ad orcum*).

46. For example, a 1655 treatise on Scottish law based on civil law sources described a landowner’s rights to subsurface coal with the phrase *omnia que inter coelum et inferos*, translated as “everything under the surface—from the sky to the centre of the earth.” 1 CRAIG, *supra* note 8, at 525.

cujus est solum, ejus est ad coelum became *cujus est solum, ejus est ad coelum et ad inferos* (the *ad inferos* maxim).

3. American Adoption of the Center of the Earth Theory

Blackstone's *Commentaries* had a profound impact on the new United States. Prized for their clear structure, comprehensive scope, and engaging prose, the *Commentaries* served as the foundation for the emerging American legal system.⁴⁷ As Daniel Boorstin famously noted, "no other book—except the Bible—has played so great a role" in shaping American institutions.⁴⁸ Indeed, Stephen Feldman explained that "[t]he American faith in natural law was, to a great extent, inherited from William Blackstone."⁴⁹ Propelled by Blackstone's endorsement, the center of the earth theory slowly spread to the United States.

The theory first appeared in American law in the 1797 decision of *State v. David*.⁵⁰ David was indicted in Delaware for stealing two barrels of herrings, after the barrels were found buried on his land. The prosecution argued that the barrels were "in defendant's possession, because everything above and below the soil belongs to the possessor of the soil,"⁵¹ and David was found guilty. His defense counsel James Wilson, who included the decision in his widely circulated collection of early American cases, added a notation in the book that "[t]he rule, *usque ad caelum et inferos*, only relates to appurtenances," and therefore should not have been used by the court.⁵²

In *David*, the barrels were located only a few feet below the land surface, so the issue was whether the surface owner held title to the subsurface zone within five feet of the surface—not who owned the subsurface ten miles or one hundred miles below. The use of the center of the earth theory in this context was overkill; to paraphrase Justice Blackmun's remark in a different context, it was using "a missile to kill a mouse."⁵³ In fact, the *David* court would have reached the same result by applying the pre-Blackstone

47. See generally Alschuler, *supra* note 34, at 4–19 (discussing the impact of Blackstone on American law).

48. DANIEL J. BOORSTIN, *THE MYSTERIOUS SCIENCE OF THE LAW*, at iii (Beacon Press 1958) (1941).

49. Stephen M. Feldman, *From Premodern to Modern American Jurisprudence: The Onset of Positivism*, 50 VAND. L. REV. 1387, 1395 (1997).

50. 1 Del. Cas. 160 (1797).

51. *Id.* at 160.

52. *Id.*

53. *Lucas v. S.C. Coastal Council*, 505 U.S. 1003, 1036 (1992) (Blackmun, J., dissenting).

approach to subsurface ownership: The surface owner owns those portions of the near-surface zone that he actually uses.

David foreshadowed the hyperbolic manner in which later American decisions and treatises utilized Blackstone's invention. Nineteenth-century courts often quoted the center of the earth language to justify protecting the surface owner, but almost all of these cases involved situations in which the disputed region was relatively shallow, usually less than one hundred feet deep.⁵⁴ Similarly, leading American authors such as James Kent adopted the center of the earth standard without providing any analysis or justification other than a citation to Blackstone's text.⁵⁵ For Kent and other American legal scholars of his era, Blackstone's *Commentaries* were literally gospel—to be followed without question. Indeed, Kent's experience of reading Blackstone at age fifteen had inspired him to become a lawyer.⁵⁶

By the end of the nineteenth century, judges and scholars had repeated Blackstone's assertion so frequently that it was assumed to be a rule of American law.⁵⁷ Representative of the era, one treatise explained that “the correct legal idea of land, or of real property, is of a portion of the earth whose boundaries, beginning at a point in the center of the earth, extend straight upwards to the earth's surface, and indefinitely upward beyond.”⁵⁸ Many courts wrongly assumed that this was an ancient principle, from the “early days of the common law,”⁵⁹ or “as old, probably, as ownership in land.”⁶⁰

54. See, e.g., *Stevenson v. Bachrach*, 48 N.E. 327 (Ill. 1897) (building foundation); *Cockrill v. Downey*, 4 Kan. 426 (1868) (tree roots); *Wheatley v. Baugh*, 25 Pa. 528 (1855) (groundwater); *Goodall v. City of Milwaukee*, 5 Wis. 32 (1856) (road easement).

55. See, e.g., JOSEPH K. ANGELL, *A TREATISE ON THE LAW OF WATERCOURSES* 1 (Boston, Charles C. Little & James Brown 3d ed. 1840); 3 JAMES KENT, *COMMENTARIES ON AMERICAN LAW* 321 (N.Y., O. Halsted 1826–30). In the second half of the nineteenth century, legal dictionaries also began to endorse this view. See, e.g., *BLACK'S LAW DICTIONARY* 306 (1891) (listing the *ad inferos* maxim, defined as meaning: “To whomsoever the soil belongs, he owns also to the sky and to the depths. The owner of a piece of ground owns everything above and below it to an indefinite extent.”).

56. Alschuler, *supra* note 34, at 6.

57. See, e.g., *Lincoln-Lucky & Lee Mining Co. v. Hendry*, 50 P. 330, 332 (N.M. 1897) (“rule”); *Del. & Hudson Canal Co. v. Hughes*, 38 A. 568, 569 (Pa. 1897) (“general rule”).

58. JOHN G. HAWLEY & MALCOLM MCGREGOR, *A TREATISE ON THE LAW OF REAL PROPERTY* 5 (4th ed. 1910); see also EARL P. HOPKINS, *HANDBOOK ON THE LAW OF REAL PROPERTY* 3–4 (St. Paul, West Publ'g Co. 1896); 1 ALFRED G. REEVES, *A TREATISE ON THE LAW OF REAL PROPERTY* 73 (1909).

59. *Barker v. Campbell-Ratcliff Land Co.*, 167 P. 468, 470 (Okla. 1917).

60. *Becket v. Clark*, 40 Conn. 485, 488 (1873); see also *Hannabalsen v. Sessions*, 90 N.W. 93, 95 (Iowa 1902) (“[The *ad inferos* maxim] is one of the oldest rules of property known to the law . . .”).

B. The Center of the Earth Theory Today

Most modern legal texts continue to endorse the center of the earth theory.⁶¹ For example, one well-known treatise echoes the “traditional view” that the owner’s “right to exclusive possession extends downward ‘to the center of the earth’” such that “ownership is viewed as extending downward indefinitely.”⁶² Another states that “[t]he title of the owner of land presumptively extends upward indefinitely and downward to the earth’s center, embracing everything upon the surface and everything beneath it.”⁶³ A third source explains that a tract of land

is an inverted pyramid having its tip, or apex, at the center of the earth, extending outward through the surface of the earth at the boundary lines of the tract, and continuing on upward to the heavens.⁶⁴

A few treatises adopt a more cautious approach to the issue: They acknowledge that the surface owner’s rights reach below the surface, but they ignore the difficult issue of how far downward those rights extend. Thus, one text merely provides that “[t]he possessory interest in property also extends below the surface of the land.”⁶⁵ Another notes that “[t]he law recognizes . . . the right of the surface owner to the exclusive possession of the earth, minerals, and other substances below the surface of the land.”⁶⁶

61. See, e.g., 63C AM. JUR. 2D *Property* § 12 (1997) (citing the Latin maxim for the proposition that “the title to land extends downward from the surface to the center of the earth”); VI-A AMERICAN LAW OF PROPERTY § 28.3 (A. James Casner ed., 1954) (noting that the “surface possessor’s right to exclusive possession extends downward *usque ad inferos*,” except where mineral rights have been severed or mineral claimants have extralateral rights); 73 C.J.S. *Property* § 23 (2004) (“Land includes not only the face of the earth but everything under it or over it, and has in its legal signification an indefinite extent upward and downward.”).

62. WILLIAM B. STOEBUCK & DALE A. WHITMAN, *THE LAW OF PROPERTY* 25–26, 412 (3d ed. 2000) (stating the “traditional view” but noting an exception where the mineral rights have been severed from the surface). Indeed, my own treatise is similarly overbroad. After characterizing the center of the earth standard as a common law “theory,” it nonetheless states that “[c]ontemporary courts still protect the surface owner’s absolute right to possession when third parties intrude into the subsurface, whether by mining, installing a pipeline, or otherwise.” JOHN G. SPRANKLING, *UNDERSTANDING PROPERTY LAW* 520 (2d ed. 2007). This assessment is correct only within the near-surface zone.

63. 2 THOMPSON ON REAL PROPERTY § 14.04(a) (David A. Thomas ed., 2d ed. 2000) (stating the doctrine but noting that it is subject to “many qualifications when actually applied”).

64. ROBERT KRATOVIL & RAYMOND J. WERNER, *REAL ESTATE LAW* 4 (9th ed. 1988).

65. 9 RICHARD R. POWELL, *POWELL ON REAL PROPERTY* § 64A.01[6] (Michael Allan Wolf ed., 2007).

66. 1 FOWLER V. HARPER ET AL., *HARPER, JAMES AND GREY ON TORTS* § 1.5 (3d ed. 2006).

In practice, almost all modern cases continue to embrace the center of the earth fiction.⁶⁷ Some decisions recite the complete *ad inferos maxim*⁶⁸ in Latin—including an English translation⁶⁹—while others merely proclaim that the surface owner owns to the “center of the earth”⁷⁰ or “to the depths.”⁷¹ Thus, for example, in 2007 the Illinois Supreme Court repeated the rule that “[t]he owner in fee owns to the center of the earth.”⁷² In the same year, the Iowa Supreme Court justified a ruling, in part, by explaining that the result “conforms to the familiar legal maxim *cujus est solum, ejus est usque ad coelum et ad inferos*—[w]hoever owns the soil owns everything up to the sky and down to the depths.”⁷³

II. A GEOLOGY LESSON

Blackstone’s center of the earth theory implicitly assumed that humans could productively use the deep subsurface. Indeed, as noted above,⁷⁴ Pufendorf actually discussed digging a hole from the surface to the center of

67. A few modern decisions have expressly challenged the *ad inferos* approach. See, e.g., *Chance v. BP Chems., Inc.*, 670 N.E.2d 985 (Ohio 1996); *FPL Farming, Ltd. v. Tex. Natural Res. Conservation Comm’n*, No. 03-02-00477-CV, 2003 WL 247183 (Tex. App. Feb. 6, 2003).

68. Some courts use variants of the maxim. See, e.g., *Lewis v. Sac & Fox Tribe Hous. Auth.*, 896 P.2d 503, 515 n.83 (Okla. 1994) (using the variant *a centro usque ad coelum*, translated as “land is deemed to extend from the center of the earth to the sky”); *Brooks v. City of Memphis*, 241 S.W.2d 432, 434 (Tenn. 1951) (using variant *ab infernis ad coelum*, translated as “owning it from hell to heaven”).

69. See, e.g., *Bd. of County Comm’rs v. Park County Sportsmen’s Ranch, LLP*, 45 P.3d 693, 696 n.1 (Colo. 2002) (noting that the surface owner owns “to the depths” and citing to the maxim); *Stanley v. Renshaw*, No. CV960054578S, 2002 Conn. Super. LEXIS 2001, at *4 (Conn. Sup. Ct. June 14, 2002) (same); *Nichols v. City of Evansdale*, 687 N.W.2d 562, 566 (Iowa 2004) (noting that the surface owner owns “down to the depths” and citing the maxim); *Energy Dev. Corp. v. Moss*, 591 S.E.2d 135, 143 n.14 (W. Va. 2003) (citing the maxim for the rule that the surface owner “own[s] from the heavens to the center of the earth”).

70. See, e.g., *Martin v. Sarah Rhodes, LLC*, 548 S.E.2d 365, 366 (Ga. Ct. App. 2001) (citing an earlier case for the rule that the land boundary goes down “to the center of the earth”); *Lupo v. Bd. of Assessors*, 799 N.Y.S.2d 405, 410 (Sup. Ct. 2005) (citing Blackstone for the center of the earth standard); *Foxtail Props., LLC v. Goodrich*, No. 20031050-CA, 2004 Utah App. LEXIS 335, at *2 (Utah Ct. App. Sept. 16, 2004) (citing a treatise for the rule that the title of the surface owner “presumptively extends . . . downward to the earth’s center”).

71. See, e.g., *Smith v. Mun. Court*, 245 Cal. Rptr. 300, 303 n.2 (Ct. App. 1998) (“The owner of submerged land, like the owner of dry land, owns also to the sky and to the depths . . .” (quoting *Steel Creek Dev. Corp. v. James*, 294 S.E.2d 23, 27 (N.C. Ct. App. 1982))).

72. *Kankakee County Bd. of Review v. Prop. Tax Appeal Bd.*, 871 N.E.2d 38, 52 (Ill. 2007) (quoting *Jilek v. Chi., Wilmington & Franklin Coal Co.*, 47 N.E.2d 96, 100 (Ill. 1943)).

73. *Orr v. Mortvedt*, 735 N.W.2d 610, 616 (Iowa 2007) (quoting *Nichols*, 687 N.W.2d at 566).

74. See *supra* text accompanying note 33.

the earth.⁷⁵ However, before the early 1900s, almost nothing was known about the earth's internal structure.⁷⁶ In Blackstone's era, some scientists apparently believed that the earth was a rocky sphere—potentially suitable for human use at deep levels.⁷⁷ In fact, the earth's interior is both complex and inhospitable to humans.

Today we understand that the earth consists of a thin, rigid shell essentially “floating” over a huge, rather flexible interior, somewhat like an egg.⁷⁸ This rocky shell occupies about 5 percent of the earth's volume, while its contents account for the remaining 95 percent.⁷⁹ As one commentator summarized, our planet is “an orb composed of a ridiculously dense metal pit surrounded by comparatively lighter, fluffier layers and topped off with a crispy outer crust.”⁸⁰ Based on seismic data from earthquake waves,⁸¹ twentieth century scientists concluded that the earth had four basic internal layers, each with a different chemical composition: crust, mantle, outer core, and inner core.⁸² These layers are separately discussed below.

Two key subsurface characteristics—pressure and temperature—generally increase with depth,⁸³ creating conditions in which humans cannot survive.⁸⁴ For example, while the topsoil on the outer crust might reach

75. 2 PUFENDORF, *supra* note 32, at 52.

76. LUTGENS & TARBUCK, *supra* note 5, at 329–30.

77. Most authors addressing the issue between 1600 and 1800 viewed the earth as a “solid globe” containing “empty spaces” variously called “caverns, cavities, abysses, voids, pits, crypts, bubbles, etc.” 2 FRANCOIS ELLENBERGER, *HISTORY OF GEOLOGY: THE GREAT AWAKENING AND ITS FIRST FRUITS—1660–1810*, at 18–20 (Marguerite Carozzi ed., 1999).

78. See 1 EARTH SCIENCE: THE PHYSICS AND CHEMISTRY OF THE EARTH 26 (James A. Woodhead ed., 2001) [hereinafter EARTH SCIENCE] (comparing the rigid shell components to “blocks of ice floating in a lake”).

79. This rocky shell—called the lithosphere—consists of the crust and the upper mantle and averages 100 kilometers in depth. See LUTGENS & TARBUCK, *supra* note 5, at 20. The center of the earth is about 6400 kilometers below the surface. W. KENNETH HAMBLIN & ERIC H. CHRISTIANSEN, *EARTH'S DYNAMIC SYSTEMS* 12 (8th ed. 1998). Using the standard formula for determining the volume of a sphere, the earth contains 1,099,571,746,133 cubic kilometers (cu km). A sphere with a radius of 6300 kilometers (that is, without the 100 kilometers lithosphere) has a volume of 1,048,830,476,400 cu km. Thus, the approximate volume of the lithosphere is the difference between these two figures: 50,741,269,733 cu km. This is 4.6 percent of the earth's total volume.

80. ANGIER, *supra* note 5, at 218.

81. See LUTGENS & TARBUCK, *supra* note 5, at 329–30.

82. See EARTH SCIENCE, *supra* note 78, at 37–39. The more recent trend is to view the earth as consisting of five layers defined by physical properties, not chemical composition: lithosphere, asthenosphere, mesosphere, outer core, and inner core. See, e.g., LUTGENS & TARBUCK, *supra* note 5, at 19–21. However, for simplicity this Article will use the traditional classification.

83. See LUTGENS & TARBUCK, *supra* note 5, at 19.

84. As one author observed, below about fourteen kilometers (8.7 miles) deep, “anything—drill or human—would be crushed by Earth's pressure of 50,000 pounds per square inch (4,000 times that of the atmosphere) and vaporized by a temperature of 1,000 [degrees] F.” Brad Lemley, *The Core: What Is Smack in the Center of Earth?*, SCI. WORLD, Dec. 13, 2002, at 14, 14.

30°C on a warm afternoon, the temperature at the earth's center may exceed 6700°C.⁸⁵ In a similar manner, while the air pressure at the earth's surface is a comfortable 14.7 pounds per square inch (psi), the pressure at the center is about 50 million psi.⁸⁶ Productive human activity is possible only within the shallowest portion of the earth's crust.

A third important characteristic of the earth's interior is movement. While one might imagine that the subsurface is fixed in place, like the inside of a large boulder, in reality portions of the interior are engaged in different forms of motion. The discussion below identifies five distinct types of subsurface motion, which make it impossible to delineate subsurface property rights within fixed boundaries.

A. The Crust

The earth's crust averages twenty-two to twenty-five miles in thickness under the continents, and about four miles under the oceans.⁸⁷ Humans have never penetrated below the crust. In fact, virtually all subsurface activities by humans—such as building foundations, mines, and water wells—occur in the very shallow crust within 1000 feet of the surface. The only current economic uses below this point in the United States are oil and gas wells, special wells used for the disposal of chemical wastes, and certain mines; but none of these uses exceeds six miles in depth.⁸⁸ While it does contain coal, gold, oil, and many other valuable minerals, almost 60 percent of the continental crust is a compound of silicon and oxygen.⁸⁹

Even in the shallow crust, the temperature is quite high. For instance, at a depth of only two miles, temperatures range from 50°C to 150°C;⁹⁰ in other words, much of the crust at this level is hotter than boiling water. Yet a human is in imminent danger of fatal heatstroke when his body

85. LUTGENS & TARBUCK, *supra* note 5, at 19.

86. ANGIER, *supra* note 5, at 219.

87. LUTGENS & TARBUCK, *supra* note 5, at 19.

88. For example, the deepest oil well in Oklahoma—a major oil-producing state—is only about five miles deep. See MARK C. SNEAD, OKLAHOMA STATE UNIVERSITY, THE ECONOMICS OF DEEP DRILLING IN OKLAHOMA 7 fig. 5 (2005), <http://economy.okstate.edu/papers/economics%20of%20deep%20drilling.pdf>. In fact, the average depth of oil and gas wells in the United States is about one mile. ENERGY INFO. ADMIN., AVERAGE DEPTH OF CRUDE OIL AND NATURAL GAS WELLS, http://tonto.eia.doe.gov/dnav/pet/pet_crd_welldep_s1_a.htm (last visited Feb. 12, 2008).

89. FRANK PRESS & RAYMOND SIEVER, EARTH 388 (4th ed. 1986).

90. MASS. INST. OF TECH., THE FUTURE OF GEOTHERMAL ENERGY: IMPACT OF ENHANCED GEOTHERMAL SYSTEMS (EGS) ON THE UNITED STATES IN THE 21ST CENTURY 2–15 (2006) [hereinafter MIT STUDY].

temperature reaches only 40°C.⁹¹ The estimated temperature at the bottom of the crust ranges from 400° to 800°C,⁹² higher than the average surface temperature on Venus.⁹³ To put this level of heat in context, it is greater than the melting point of either lead or tin.⁹⁴ The pressure level at the crust-mantle boundary is approximately 165,000 psi, more than four times the level of pressure that steel can withstand.⁹⁵ In short, humans cannot survive more than a few seconds under such conditions.

The dominant form of crust movement is continental drift, which is produced by plate tectonics. The crust and portions of the upper mantle are divided into seven to ten large “plates” about fifty miles thick, which float on top of a layer of molten or nearly molten rock.⁹⁶ Propelled by convective flow from the lower mantle, these plates move about four inches per year.⁹⁷ Almost all of the United States is located on the North American plate, which is moving slowly westward in relation to the lower mantle.⁹⁸

B. The Mantle

The mantle was discovered in 1906, when a seismologist noticed that certain earthquake waves moving downward in the crust were soon reflected upward by a layer of denser material.⁹⁹ In fact, there is a “marked change in

91. NAT'L INST. FOR OCCUPATIONAL SAFETY & HEALTH, U.S. DEP'T OF HEALTH AND HUMAN SERVS., OCCUPATIONAL EXPOSURE TO HOT ENVIRONMENTS, REVISED CRITERIA 85 (1986) [hereinafter NIOSH CRITERIA].

92. PRESS & SIEVER, *supra* note 89, at 374.

93. The surface temperature of Venus—the hottest planet in our solar system—is about 475°C. 12 THE NEW ENCYCLOPEDIA BRITANNICA 311 (15th ed. 1992).

94. 15 THE NEW ENCYCLOPEDIA BRITANNICA, *supra* note 93, at 962.

95. The pressure at a depth of forty kilometers (24.9 miles) is 11.2 kilobars. JEAN-PAUL POIRIER, INTRODUCTION TO THE PHYSICS OF THE EARTH'S INTERIOR 236 (1991). 11.2 kilobars, converted to pounds per square inch (psi), the most common measurement of pressure used in the United States, is over 165,000 psi. The tensile strength of steel is about 40,000 psi. *Commerce Resources Corp. Announces 17 Drill Holes on Upper Fir Extend Strike to Over 1 Kilometer*, CANADA NEWSWIRE, Oct. 1, 2007, available at <http://www.commerceresources.com/s/News-Releases.asp?ReportID=263900>. Put another way, the pressure at the crust-mantle boundary is roughly equal to the force produced by trying to hold two jumbo jets in the palm of one's hand. A Boeing 747 weighs about 870,000 pounds. Charity Trelease Ryabinkin, *Let There Be Flight: It's Time to Reform the Regulation of Commercial Space Travel*, 69 J. AIR L. & COM. 101, 106 n.16 (2004). Assuming that a human palm is twelve square inches in size, then the force exerted by 1.74 million pounds (two jets) distributed over twelve inches is 145,000 psi, slightly less than the 165,000 psi pressure at the boundary.

96. ANGIER, *supra* note 5, at 223. There are also various minor plates. *Id.*; see also HAMLIN & CHRISTIANSEN, *supra* note 79, at 13.

97. ANGIER, *supra* note 5, at 223.

98. See LUTGENS & TARBUCK, *supra* note 5, at 360.

99. EARTH SCIENCE, *supra* note 78, at 32.

chemical composition” at the border between the crust and the mantle—a higher concentration of oxygen and silicon—which produces this increased density.¹⁰⁰

Occupying over 80 percent of the earth’s total volume, the mantle extends downward beneath the crust to 1800 miles.¹⁰¹ Despite several modern efforts, humans have not yet penetrated past the crust-mantle border.¹⁰² This “elusive frontier has been a symbolic goal for many geologists, but beyond the reach of available drilling technology.”¹⁰³ However, a specially designed drilling vessel operated by the Integrated Ocean Drilling Program, an international research effort, is capable of drilling through the oceanic crust into the mantle, and planning for this project is now underway.¹⁰⁴

The pressure and the temperature of the mantle create conditions that effectively prohibit any meaningful human use of this region, given present technology. Even the pending attempt to drill into the mantle as a scientific experiment faces challenges; the organizers candidly admit that “[t]he temperature and cost limits beyond which we are unlikely to successfully drill are currently unknown.”¹⁰⁵ One major question is the effect of “thermal stress on hole stability,” that is, the risk that the hot mantle rock will “flow” so as to close the hole when the drill bit is removed.¹⁰⁶ Subsurface temperatures steadily increase from perhaps 600°C at the crust-mantle border to between 3500° to 5000°C at the mantle-core border.¹⁰⁷ Thus, for example, the temperature in the middle of the mantle is high enough to melt iron.¹⁰⁸ Similarly, the pressure accelerates from 165,000 psi near the crust to almost 21 million psi next to the core.¹⁰⁹

The components of the mantle move both horizontally and vertically. While part of the mantle consists of molten rock,¹¹⁰ most of it has the

100. LUTGENS & TARBUCK, *supra* note 5, at 19.

101. *Id.*

102. The world’s deepest borehole is located on the Kola Peninsula in Russia, which extends down 40,200 feet, or about 7.6 miles. See Kurt Bram et al., *The KTB Borehole: Germany’s Superdeep Telescope Into the Earth’s Crust*, 7 OILFIELD REV. 4, 7 (1995), <http://www.slb.com/media/services/resources/oilfieldreview/ors95/jan95/01950422.pdf>.

103. Ildefonse et al., *supra* note 2, at 11.

104. *Id.* at 16.

105. *Id.*

106. *Id.*

107. R.T. Merrill & P.L. McFadden, *Paleomagnetism and the Nature of the Geodynamo*, 248 SCI. 345, 346 (1990) (“Most investigators would place the temperature of the core-mantle boundary between 3500 [degrees] and 5000 [degrees] C.”).

108. Iron melts at 1536°C. 15 THE NEW ENCYCLOPEDIA BRITANNICA, *supra* note 93, at 991.

109. The pressure at 2971 kilometers (1846.1 miles) is 1442 kilobars. POIRIER, *supra* note 95, at 237. This is the equivalent of 20,914,442 psi.

110. LUTGENS & TARBUCK, *supra* note 5, at 20.

consistency of Silly Putty.¹¹¹ Thus, it tends to flow around the earth's core, at a rate of up to four inches each year.¹¹² In addition, as noted above, portions of the upper mantle move separately from the lower mantle due to continental drift. Finally, convective forces within the mantle cause vertical movement: "[W]arm buoyant rock rises and cooler, dense material sinks—[which] is the underlying driving force for plate movement."¹¹³ Of course, this "warm" rock is largely molten lava—the raw material for volcanic eruptions on the earth's surface.

C. The Outer Core

The earth's outer core was also discovered in 1906.¹¹⁴ It consists of a layer of molten metal—apparently an iron-nickel alloy¹¹⁵—that is about 1410 miles thick, extending downward to about 3170 miles.¹¹⁶ Predictably, both the temperature and the pressure are extremely high. At the boundary with the inner core, the temperature is thought to be approximately 5000°C,¹¹⁷ hotter than the outer layer of the sun.¹¹⁸ In the same location, the estimated pressure is over 47 million psi.¹¹⁹

The viscosity of the liquid metal in the outer core is akin to water.¹²⁰ Traveling around the inner core at a velocity of about six miles per year, this molten material produces the earth's magnetic field.¹²¹ Life on earth

111. ANGIER, *supra* note 5, at 220 ("Like Silly Putty, the mantle is solid but springy, almost squishy, and it can move and it does all the time.")

112. *Id.*; see also LUTGENS & TARBUCK, *supra* note 5, at 21 (noting that the rocks in the lower mantle are "still very hot and capable of very gradual flow").

113. LUTGENS & TARBUCK, *supra* note 5, at 359.

114. C.M.R. FOWLER, *THE SOLID EARTH: AN INTRODUCTION TO GLOBAL GEOPHYSICS* 2 (2d ed. 2005).

115. LUTGENS & TARBUCK, *supra* note 5, at 329 (referring to liquid "iron-nickel alloy").

116. EARTH SCIENCE, *supra* note 78, at 38 (discussing the depth of the outer core).

117. Bruce A. Buffett, *The Thermal State of the Earth's Core*, 299 *SCI.* 1675, 1675 (2003) (summarizing estimates from 5000° to 6000°K; the Kelvin scale modifies the Centigrade scale by beginning at absolute zero, which is -273.18°C).

118. The outer boundary of the sun has a temperature of about 4200°K. 27 *THE NEW ENCYCLOPEDIA BRITANNICA*, *supra* note 93, at 510.

119. The pressure at this depth is thought to be 3245 kilobars. POIRIER, *supra* note 95, at 237. This translates to 47,064,746 psi.

120. Bruce A. Buffett, *Dynamics of the Earth's Core*, in *EARTH'S DEEP INTERIOR: MINERAL PHYSICS AND TOMOGRAPHY FROM THE ATOMIC TO THE GLOBAL SCALE* 37 (Shun-ichiro Karato et al. eds., 2000).

121. ANGIER, *supra* note 5, at 219 (discussing the formation of the magnetic field); Buffett, *supra* note 120, at 37 (discussing the viscosity and the velocity of the liquid metal, which travels 10,000 meters or 6.2 miles each year).

depends on this field, which helps shelter the surface from dangerous solar radiation such as gamma rays and X-rays.¹²²

D. The Inner Core

As one author observed, “[t]he dream of exploring our planet’s center is probably as old as our understanding that the earth is round . . . and therefore has a center.”¹²³ But despite occasional proposals, humans have never made a serious effort to reach the center, which is located in the inner core.¹²⁴ Interestingly, it is difficult to even determine the true center of the earth: “The problem is very much akin to measuring the center of mass of a glob of Jell-O, because Earth is constantly changing shape due to tectonic and climatic forces.”¹²⁵

Discovered in 1936,¹²⁶ the inner core is a relatively solid iron-nickel sphere¹²⁷ that occupies less than 1 percent of earth’s volume.¹²⁸ It extends downward for about 750 miles to the true center of the earth, 3900 miles below the surface.¹²⁹ Predictably, the temperature and pressure are intense. The temperature at the center of the earth may exceed 6700°C,¹³⁰ while the pressure is greater than 50 million psi.¹³¹

Although scientists debate the consistency of the inner core, some believe that it is akin to “very stiff Silly Putty.”¹³² Thus, the extent of movement within the inner core, if any, is unknown. But it is widely agreed that the inner core is rotating more quickly than the rest of the earth, moving eastward at over sixty miles per year in relation to the surface.¹³³

122. See ANGIER, *supra* note 5, at 219.

123. William Speed Weed, *The 3rd Annual Year in Ideas: The Jules Verne Project*, N.Y. TIMES MAG., Dec. 14, 2003, at 79.

124. For example, David Stevenson has suggested using a nuclear explosion to launch a mass containing liquid iron and small probes toward the core. David J. Stevenson, *Mission to Earth’s Core: A Modest Proposal*, 423 NATURE 239, 239 (2003).

125. NASA Scientist Finds a New Way to the Center of the Earth, SCIENCE DAILY, June 12, 2007, <http://www.sciencedaily.com/releases/2007/06/070612084458.htm>.

126. LUTGENS & TARBUCK, *supra* note 5, at 330.

127. *Id.* at 19; see also ANGIER, *supra* note 5, at 219.

128. J.A. JACOBS, DEEP INTERIOR OF THE EARTH 1 (1992).

129. LUTGENS & TARBUCK, *supra* note 5, at 329.

130. *Id.* at 19.

131. ANGIER, *supra* note 5, at 219.

132. Stephen Battersby, *Watch That Wobble*, NEW SCIENTIST, Feb. 18, 2006, at 42, 44.

133. Phil Berardelli, *Geologists Now Know What Makes the World Go ‘Round*, INSIGHT ON NEWS, Aug. 19, 1996, at 38, 38.

III. DEMISE OF THE CENTER OF THE EARTH THEORY

A. The Theory as Hyperbole: Below Two Miles

1. The Limits of Dicta

It is axiomatic that dicta are not binding in our common law system. As the U.S. Supreme Court has explained, dicta “may be followed if sufficiently persuasive but . . . are not controlling.”¹³⁴ Although the line between dicta and holding is sometimes difficult to discern, the traditional rule is that dicta refers to one or more statements in a judicial opinion that are logically unnecessary to the resolution of the case.¹³⁵ The reason for the dicta-holding dichotomy is straightforward: “Dicta are less carefully considered than holdings, and, therefore, less likely to be accurate statements of law.”¹³⁶

No appellate decision has ever considered whether private property rights extend to the mantle, the outer core, or the inner core. Thus, all past judicial statements about ownership to the “center of the earth”¹³⁷ must be considered dicta as to these regions, simply because such statements were not necessary to resolving the actual cases presented, all of which involved the crust—and, indeed, only the very shallow crust.¹³⁸ The physical conditions

134. *Humphrey's Ex'r v. United States*, 295 U.S. 602, 627 (1935). See generally Michael Abramowicz & Maxwell Stearns, *Defining Dicta*, 57 STAN. L. REV. 953 (2005); Michael C. Dorf, *Dicta and Article III*, 142 U. PA. L. REV. 1997 (1994).

135. See Abramowicz & Stearns, *supra* note 134, at 1056 (noting that the “most influential definition” of dictum is found in *Black's Law Dictionary*, which defines it as a “judicial comment made while delivering a judicial opinion, but one that is unnecessary to the decision in the case and therefore not precedential” (quoting BLACK'S LAW DICTIONARY 485 (8th ed. 2004))).

136. Dorf, *supra* note 134, at 2000. Michael Dorf also identifies a second, but less vital, rationale: legitimacy. *Id.* at 2000–01 (“According to this view, dicta have no precedential effect because courts have legitimate authority only to decide cases, not to make law in the abstract.”).

137. See, e.g., decisions cited *supra* notes 67–73.

138. The expression of the center of the earth theory in the form of a maxim makes no difference to this analysis, as the air rights decisions demonstrate. While maxims represented important “nuggets of legal wisdom” in the early common law period, their influence declined with the evolution of legal positivism, which emphasizes “facts rather than concepts.” J. Stanley McQuade, *Ancient Legal Maxims and Modern Human Rights*, 18 CAMPBELL L. REV. 75, 76–78 (1996). The “disappearance of maxim jurisprudence” has been attributed to the influence of John Austin and Jeremy Bentham. *Id.* at 78. As Roscoe Pound observed, a nineteenth-century “attempt to revive a jurisprudence of maxims came to nothing.” Roscoe Pound, *The Maxims of Equity—I*, 34 HARV. L. REV. 809, 836 (1921). Modern authorities tend to view maxims with suspicion, as dangerous overstatements. Even Blackstone conceded that a maxim could not be viewed as a “rule of the common law” unless it could be shown that “it hath been always the custom to observe it.” 1 BLACKSTONE, *supra* note 6, at *67–68. As discussed below, see *infra* pp. 1003–04, American courts have typically ignored the center of earth theory, even in disputes within a mile or two of the surface.

deep within the earth—including movement, pressure, resources, and temperature—are fundamentally different from those within the crust that courts may have considered in past decisions. In fact, as discussed above,¹³⁹ the center of the earth approach evolved in the late eighteenth century, long before twentieth-century scientists discovered the complexity of the earth's interior.

The evolution of property rights in airspace provides a helpful model for assessing the scope of ownership rights within the crust. As discussed above,¹⁴⁰ the surface owner's rights in airspace and the subsurface were seen as parallel: According to Blackstone's formulation, an owner's title extended up to the heavens and down to the center of the earth. Indeed, both sets of rights were linked together in the "popular ear-catching Latin maxim,"¹⁴¹ *cujus est solum, ejus est usque ad coelum et ad inferos*.

American courts repeatedly advanced this expansive view of airspace rights—until the invention of the airplane sparked litigation, especially in the 1930s. In this new environment, the Georgia Supreme Court explained that the "maxim . . . is a generalization from old cases involving title to [air]space within the range of actual occupation, and any statement as to title beyond was manifestly a mere dictum."¹⁴² Striking a similar chord, the Ninth Circuit rejected the *ad coelum* approach to airspace: "We think it is not the law, and that it never was the law."¹⁴³ It proceeded to explain that the maxim "simply meant that the owner of the land could use the overlying space to such an extent as he was able,"¹⁴⁴ not that his title literally extended to the heavens.

Based on similar arguments, courts across the nation rapidly jettisoned the *ad coelum* approach to airspace rights, most commonly by finding that the surface owner's rights extended upward only far enough to accommodate normal surface uses.¹⁴⁵ The completion of this process is symbolized by the

139. See *supra* Part I.A.2.

140. See *supra* text accompanying notes 28–29.

141. *Frost v. City of Ponca City*, No. 47326, 1975 Okla. Civ. App. LEXIS 103, at *8 (Okla. Ct. App. Jan. 14, 1975).

142. *Thrasher v. City of Atlanta*, 173 S.E. 817, 825 (Ga. 1934); see also *State v. Layne*, 623 S.W.2d 629, 635 (Tenn. Crim. App. 1981) (noting that "[t]he maxim arose largely from dicta, since the early cases were limited to facts and conditions close to earth and did not require an adjudication of the title to the 'mansions in the sky'" (citing *Thrasher*, 173 S.E. at 825)).

143. *Hinman v. Pac. Air Transp.*, 84 F.2d 755, 757 (9th Cir. 1936).

144. *Id.*

145. See, e.g., *United Masonry, Inc. v. Jefferson Mews, Inc.*, 237 S.E.2d 171, 181 (Va. 1977) ("The common law rule that the owner of land held title to all below it to the center of the earth and all above it to the limits of the sky has been modified so that now the landowner is generally held to own only that amount of airspace he can reasonably use."); see also George Gleason Bogert, *Problems in Aviation Law*, 6 CORNELL L.Q. 271, 296 (1921) (observing, in the context of airspace rights, that the maxim "*cujus est solum* is not law, but is merely a nice theory, easily passed down from mediaeval days because there has not been until recently any occasion to apply it to its full extent").

Supreme Court's 1946 decision in *United States v. Causby*,¹⁴⁶ where the Court observed: "It is ancient doctrine that at common law ownership of the land extended to the periphery of the universe—*Cujus est solum ejus est usque ad coelum*. But that doctrine has no place in the modern world."¹⁴⁷

The same analysis should logically apply to subsurface rights. The deepest subsurface dispute ever litigated in the United States occurred in *Nunez v. Wainoco Oil & Gas Co.*,¹⁴⁸ in which the defendant drilled an oil well that first entered the plaintiff's land about two miles below the surface.¹⁴⁹ Although the Louisiana Supreme Court recognized that a normal surface owner would hold title to the center of the earth,¹⁵⁰ it held that specialized state statutes superseded subsurface property rights in designated oil production regions, and accordingly rejected the plaintiff's trespass claim.¹⁵¹ Even if we charitably characterize the court's endorsement of the center of the earth theory as a holding, any suggestion that this approach extends into the crust below two miles is mere dicta, which binds no one. Human activity has, quite literally, barely scratched the surface of our planet.¹⁵²

2. Statutory Failures

A small group of states have adopted legislation that addresses the general extent¹⁵³ of subsurface property rights. But these statutes are ambiguous at best and do little to resolve the problems inherent in Blackstone's theory.

146. 328 U.S. 256 (1946).

147. *Id.* at 260–61.

148. 488 So. 2d 955 (La. 1986).

149. *Id.* at 956.

150. Much of the law governing subsurface rights in Louisiana is statutory. The *Nunez* court relied on Louisiana Civil Code article 490 (2007), which provides, in part: "Unless otherwise provided by law, the ownership of a tract of land carries with it the ownership of everything that is directly above it or under it." 488 So. 2d at 959 n.9 (quoting LA. CIV. CODE ANN. art. 490). Thus, the statute fails to answer the basic question: How far down do property rights go? The court apparently assumed that the statute extended property rights to the center of the earth. *See id.*

151. 488 So. 2d at 963–64.

152. Perhaps the most famous subsurface rights case is *Edwards v. Sims*, 24 S.W.2d 619 (Ky. Ct. App. 1929), involving title to the Great Onyx Cave, which is approximately 360 feet underground. While the majority suggested that the cave belonged to the surface owners under the center of the earth standard, *id.* at 620, the dissent favored the owner who owned the cave entrance:

It sounds well in the majority opinion to tritely say that he who owns the surface of real estate . . . owns from the center of the earth to the outmost sentinel of the solar system.

The age-old statement, adhered to in the majority opinion as the law, in truth and fact, is not true now and never has been.

Id. at 622 (Logan, J., dissenting).

153. By "general extent," I mean to exclude statutes that address specific subsurface rights, such as ownership of groundwater, regulation of oil and gas production, or the like. *See infra* text accompanying notes 182–183, 199–202.

Louisiana, Montana, North Dakota, Oklahoma, and South Dakota all utilize virtually the same statutory text, providing that the surface owner “has the right to the surface and to everything permanently situated beneath or above it.”¹⁵⁴ However, they fail to define how far downward the owner’s rights extend. As a result, some courts apply the center of the earth standard to interpret this language.¹⁵⁵ Accordingly, the dicta analysis above is equally applicable to these judicial pronouncements: None of these cases has adjudicated rights below two miles.

The confusion is more pronounced in jurisdictions such as Alabama, California, Georgia, and Idaho. Although the precise language varies somewhat, here the relevant statutes share the theme that property rights extend downward “indefinitely” or “for an indefinite distance.”¹⁵⁶ Taken literally, this language creates two difficulties. First, it suggests that the surface owner holds title to a subsurface pillar that is equal in width and breadth to his surface parcel, akin to a cylinder rather than a pyramid. Because the earth is round, the theoretical pillars of different owners would quickly intersect with each other—an absurd result. Second, a subsurface pillar of infinite length would pass through the center of the earth and exit the land surface in a direct line below. For example, this view would give an Alabama landowner exclusive rights to the surface of land in China—another logical absurdity.¹⁵⁷ It is a fundamental precept that a statute

154. LA. CIV. CODE ANN. art. 490 (1980); MONT. CODE ANN. § 70-16-101 (2006); N.D. CENT. CODE § 47-01-12 (1999); OKLA. STAT. ANN. tit. 60, § 64 (West 1994); S.D. CODIFIED LAWS § 43-16-1 (1997). All five statutes appear to share a common origin. The Louisiana statute essentially repeats the text of Section 552 of the French Civil Code of 1804. CODE CIVIL [C. CIV.] bk. II, tit. 1, § 552. It appears that this French Civil Code section was incorporated into Dudley Field’s model Civil Code, which was in turn adopted in California, and thence spread to the other listed states. Ironically, California amended its parallel statute, CAL. CIV. CODE § 659, in 1963 to add the “indefinite distance” language, thus creating the difficulties discussed in the text accompanying notes 156–158. CAL. CIV. CODE § 659 (West 2007).

155. See, e.g., *Nunez*, 488 So. 2d at 955.

156. ALA. CODE § 6-5-210 (1993) (“downwards and upwards indefinitely”); CAL. CIV. CODE § 659 (West 2007) (“an indefinite distance upwards as well as downwards”); GA. CODE ANN. § 44-1-2(b) (1991) (“extends downward indefinitely and upwards indefinitely”); IDAHO CODE ANN. § 55-101A (2007) (“an indefinite distance upwards as well as downwards”).

157. In addition, a number of states have enacted either the Uniform Condominium Act or the Uniform Common Interest Ownership Act. Both of these acts include an explanatory note—adopted by some, but not all, enacting states—that provides, in pertinent part: “Where real estate is described in only two dimensions (length and width), it is correctly assumed that the property extends indefinitely above the earth’s surface and downwards to a point in the center of the planet.” See, e.g., N.C. GEN. STAT. § 47C-1-103 cmt. 12 (2003). It might be argued that this reference provides indirect evidence of legislative intent to adopt the center of the earth approach outside of the condominium context.

should be interpreted, if possible, to avoid an absurd conclusion.¹⁵⁸ To date, no court has attempted to apply these statutes in a deep subsurface dispute, so their precise downward reach remains unclear. At a minimum, however, they cannot be viewed as statutory endorsements of the center of the earth approach.

B. The Theory Ignored: In the Shallow Crust

Hundreds of American appellate decisions have recited “center of the earth” language—in English, Latin, or both—in connection with disputes within the region between the land surface and a point two miles deep. These cases may be divided into two categories.¹⁵⁹

One group of cases involves uses either at¹⁶⁰ or a few feet below the surface, such as tree roots¹⁶¹ or sewer lines.¹⁶² Courts in such cases often cite the center of the earth theory to justify protecting the surface owner’s rights, even though this usage goes well beyond the needs of the immediate case. Here, the doctrine functions merely as a convenient shorthand for the idea that a landowner owns the subsurface to the extent necessary to support normal and reasonable uses of the surface.¹⁶³ Few would disagree with this general proposition of law.¹⁶⁴ Indeed, it is

158. *Johnson v. United States*, 529 U.S. 694, 706 n.9 (2000) (“[N]othing is better settled, than that statutes should receive a sensible construction, such as will effectuate the legislative intention, and, if possible, so as to avoid an unjust or absurd conclusion[.]”) (alteration in original) (quoting *In re Chapman*, 166 U.S. 661, 667 (1897)).

159. Of course, many courts also include center of the earth rhetoric in decisions in which subsurface rights are not at issue. See, e.g., *Templeton v. Metro. Gov’t of Nashville*, 650 S.W.2d 743, 758 (Tenn. Ct. App. 1983) (rejecting a challenge to the denial of a liquor license application).

160. Courts dealing with surface water rights or surface flooding disputes frequently observe that the title of the surface owner extends from the heavens to the center of the earth, sometimes using the full Latin maxim. See, e.g., *Orr v. Mortvedt*, 735 N.W.2d 610, 616 (Iowa 2007); *Grosso v. Long Island Lighting Co.*, 424 N.Y.S.2d 979, 982 (Dist. Ct. 1980). It is not always clear which prong of the doctrine these courts are using in such disputes, the air rights portion or the subsurface portion.

161. See, e.g., *Harding v. Bethesda Reg’l Cancer Treatment Ctr.*, 551 So. 2d 299 (Ala. 1989).

162. See, e.g., *Nichols v. City of Evansdale*, 687 N.W.2d 562, 566 (Iowa 2004).

163. Of course, this right is subject to various restrictions, such as those imposed by land use regulations. See, e.g., *Krantz v. Town of Amherst*, 80 N.Y.S.2d 812, 817 (App. Div. 1948) (upholding an ordinance that prohibited the plaintiff from removing topsoil from land zoned for agricultural purposes, because “the old absolute ownership from the center of the earth *usque ad coelum* has given way to a variety of new needs and to a broadened concept of duty to neighbor”).

164. *But cf.* *First Unitarian Soc’y v. Citizens’ Sav. & Trust Co.*, 142 N.W. 87, 92 (Iowa 1913) (holding that the presence of a public sewer pipe six feet below the land surface did not breach the grantor’s covenant against encumbrances, despite a vigorous dissent that ownership to the center of the earth is “hornbook law”).

quite consistent with the near-surface standard used by early English common law before Blackstone's intervention.¹⁶⁵

The second category of cases concerns true subsurface ownership: disputes concerning the zone from the near-surface area to two miles downward. Do courts uniformly recognize that the surface owner owns this region, as the center of the earth theory would dictate? The answer to this question is a resounding "no." Remarkably, when courts directly confront the scope of deep subsurface rights, they usually soften or ignore the center of the earth approach to the point where the exceptions swallow any supposed rule. Broadly speaking, the deeper the dispute, the less likely courts are to recognize the surface owner's title. In addition, specialized statutes have eroded the center of the earth theory. Federal and state statutes require that the surface owner obtain a permit before using the subsurface for particular purposes. Because such permits can be denied, the government has effectively limited the landowner's subsurface rights.

Property is customarily viewed as a metaphorical "bundle of rights."¹⁶⁶ The most important sticks in this bundle are: (1) the right to use and enjoy; (2) the right to exclude; and (3) the right to transfer.¹⁶⁷ The analysis below demonstrates that the law has largely eviscerated the surface owner's supposed right to use and enjoy the deep subsurface. Similarly, the owner's theoretical right to exclude others from her land is increasingly ignored in the deep subsurface, as discussed below. Certainly, the surface owner retains the right to transfer whatever subsurface rights she may have. But the scope of those rights under modern law is so meager that it cannot be fairly characterized as "title."¹⁶⁸

165. See *supra* Part I.A.1.

166. See, e.g., *Kaiser Aetna v. United States*, 444 U.S. 164, 176 (1979) (mentioning the "bundle of rights that are commonly characterized as property"); see also *SPRANKLING*, *supra* note 62, at 4.

167. *SPRANKLING*, *supra* note 62, at 5.

168. The U.S. Supreme Court confronted a somewhat analogous situation in *Loretto v. Teleprompter Manhattan CATV Corp.*, 458 U.S. 419 (1982). There, a New York statute authorized cable television companies to install cables and related equipment on any privately owned rental property without the owner's consent, in exchange for nominal consideration. The Supreme Court held that the statute was a taking because it "effectively destroys" key ownership rights: "[T]he owner has no right to possess the occupied space himself, and also has no power to exclude the occupier from possession . . ." *Id.* at 435. The Court noted that although the owner retained "the bare legal right to dispose of the occupied space by transfer," the occupation of that space by a stranger "will ordinarily empty the right of any value." *Id.* at 436.

1. The Right to Use and Enjoy

The right to use and enjoy is perhaps the most important stick in the metaphorical bundle. As Coke asked almost 400 years ago, “what is the land but the profits thereof?”¹⁶⁹ In the modern era, the Supreme Court has emphasized its “abiding concern for the productive use of, and economic investment in, land.”¹⁷⁰

American decisions concerning the right to use and enjoy subsurface lands address only five main topics: (a) groundwater; (b) oil and gas; (c) hard rock minerals, such as gold; (d) objects embedded in the soil; and (e) waste disposal. In fact, these are the only economically productive uses of the subsurface currently possible, other than near-surface uses such as tree roots, building foundations, and the like. When assembled like pieces of a jigsaw puzzle, these decisions reveal a picture of subsurface ownership that is inconsistent with the center of the earth theory.

a. Groundwater

For centuries, landowners have utilized wells to extract percolating groundwater for use on the surface of their lands for purposes such as agriculture, industry, and mining. The center of the earth approach logically means that each surface owner is entitled to the particular groundwater underneath his or her land. Thus, for example, adjoining owners A and B would each be entitled to withdraw the groundwater beneath their respective parcels. Conversely, if A’s pumping attracted the groundwater from B’s land, then B could recover damages for the seizure of her property. But most jurisdictions refuse to recognize that a person like B owns the groundwater under her land. In general, the center of the earth theory does not apply to groundwater.

Ironically, the earliest approach to groundwater ownership—variously called the “absolute ownership” or “absolute dominion” rule¹⁷¹—purported to apply the center of the earth standard. In 1843, the English case of *Acton v. Blundell*¹⁷² concluded that ownership of groundwater “falls within that principle, which gives to the owner of the soil all that lies beneath his

169. 1 COKE, *supra* note 13, at 4.b.

170. *Lucas v. S.C. Coastal Council*, 505 U.S. 1003, 1019 n.8 (1992).

171. See, e.g., *Hawley v. Kansas Dep’t Agric.*, 132 P.3d 870, 879 (Kan. 2006) (discussing history of “absolute ownership” doctrine); *McNamara v. City of Rittman*, 838 N.E.2d 640, 643 (Ohio 2005) (discussing history of “absolute dominion” standard).

172. (1843) 12 M. & W. 324, 152 Eng. Rep. 1223.

surface . . . whether it is solid rock, or porous ground, or venous earth, or part soil, part water.”¹⁷³ But the *Acton* court then leaped to the conclusion that the surface owner could remove as much groundwater as he wished, even if this “intercepts or drains off the water collected . . . in his neighbor’s well.”¹⁷⁴

Despite the misleading title of this doctrine, the surface owner did not in fact “own” the water in place under his land.¹⁷⁵ Title to groundwater was obtained only by removing it from the subsurface and thus converting it into personal property. This was a variant on the familiar rule of capture: Groundwater was owned by the first captor regardless of who owned the land surface.¹⁷⁶ Thus, the surface owner merely had a right to attempt to capture groundwater.

Beginning in the 1850s, American courts gradually adopted the misnamed absolute ownership approach until it became the clear majority rule.¹⁷⁷ However, during the twentieth century most states abandoned this

173. *Id.* at 1235.

174. *Id.* Some authorities have suggested that the absolute ownership approach resulted from an inadequate understanding of groundwater hydrology. See, e.g., *Vill. of Tequesta v. Jupiter Inlet Corp.*, 371 So. 2d 663, 666 (Fla. 1979) (attributing the English rule to “[t]echnological ignorance about the existence, origin, movement and course of percolating ground waters”); *State v. Michels Pipeline Constr., Inc.*, 217 N.W.2d 339, 344 (Wis. 1974) (“The basis for this rule . . . was a feeling that the ways of underground water were too mysterious and unpredictable to allow the establishment of adequate and fair rules for regulation of competing rights to such water.”).

175. See 6 THOMPSON ON REAL PROPERTY, *supra* note 63, at 763 (observing that the name of the doctrine is misleading for this reason); Eric T. Freyfogle, *Water Justice*, 1986 U. ILL. L. REV. 481, 498 (suggesting that the absolute ownership rule creates no water rights). As the California Supreme Court lamented over a century ago in *Katz v. Walkinshaw*, 74 P. 766 (Cal. 1903), under the absolute ownership rule

[t]he field is open for exploitation to every man who covets the possessions of another, or the water which sustains and preserves them, and he is at liberty to take that water if he has the means to do so, and no law will prevent or interfere with him, or preserve his victim from the attack.

Id. at 769; see also *Meeker v. City of East Orange*, 74 A. 379, 384 (N.J. 1909) (noting that it is impossible to allow adjoining landowners “the absolute right to withdraw . . . all percolating water which may be reached by a well or pump upon any one of the several lots, for such withdrawal by one owner necessarily interferes to some extent with the enjoyment of the like privilege . . . by the other owners”).

176. As the Restatement (Second) of Torts observed, “[a]lthough framed in property language, the [absolute ownership] rule was in reality a rule of capture, for a landowner’s pump could induce water under the land of his neighbor to flow to his well—water that was in theory the neighbor’s property while it remained in place.” RESTATEMENT (SECOND) OF TORTS § 857 introductory note (1979).

177. See, e.g., *Frazier v. Brown*, 12 Ohio St. 294, 304 (1861); *Chatfield v. Wilson*, 28 Vt. 49, 54–55 (1855); see also 3 WATERS AND WATER RIGHTS § 20.04, at 20-14 (Robert E. Beck ed., 1991 ed., 2003 repl. vol.). Some American courts relied on the *ad inferos* maxim to justify their adoption of this approach. See, e.g., *Meeker*, 74 A. at 384.

harsh standard.¹⁷⁸ Today, there are three main approaches to groundwater ownership: (1) reasonable use; (2) permit; or (3) correlative rights. The vast majority of jurisdictions follow either the reasonable use or the permit approaches, both of which ignore the center of the earth theory.

Many states follow the reasonable use (or American) approach, or a variant of this view based on the Restatement (Second) of Torts.¹⁷⁹ This view has been seen as an abandonment of the center of the earth approach. As one court explained, “[t]he so-called ‘American’ . . . rule rejected the ‘to the sky and to the depths’ notion for another maxim, ‘use your own property so as not to injure that of another.’”¹⁸⁰ At bottom, this is just a more equitable variant on the absolute ownership rule, which similarly requires capture, but somewhat limits how the water is to be used. Thus, the reasonable use approach ignores the center of the earth theory just as the absolute ownership view does: Under both systems, the surface owner does not own the water under her land.¹⁸¹

In other jurisdictions, title to groundwater is vested by statute in the state, not the surface owner. Thus, ownership rights in groundwater can be obtained only through a permit from the state, regardless of who owns the land surface.¹⁸² This

new and revolutionary concept . . . was a complete reversal of [prior judicial decisions], in which repeatedly it had been held that the owner of the land owned the water beneath, as an adjunct of the ancient maxim “*cujus est solum, ejus usque ad coelum et ad inferos*,” extending ownership from the center of the earth upwards to the sky’s limit.¹⁸³

Finally, perhaps four states¹⁸⁴ follow the correlative rights doctrine, under which each surface owner is entitled to a proportional share of the underlying groundwater. This view approximates the center of the earth

178. *Vill. of Tequesta*, 371 So. 2d at 666.

179. See RESTATEMENT (SECOND) OF TORTS § 857 (1979). See generally 6 THOMPSON ON REAL PROPERTY, *supra* note 63, §§ 50.11(f), 50.00(h).

180. *Vill. of Tequesta*, 371 So. 2d at 666 (citations omitted).

181. See, e.g., *id.* at 668 (“The right to use water does not carry with it ownership of the water lying under the land.”); see also *Smith v. Summit County*, 721 N.E.2d 482, 486 (Ohio Ct. App. 1998) (“[L]andowners have no title interest in the ground water underlying their properties.”).

182. As one commentator noted, “[u]nder these codes, the right to the water obviously is not considered part of the land ownership interest and must be separately acquired through compliance with the criteria established by the code.” 9 POWELL, *supra* note 65, § 65.08[3], at 65–144; see, e.g., *F. Arthur Stone & Sons v. Gibson*, 630 P.2d 1164, 1169 (Kan. 1981) (recognizing that a statutory requirement that a surface owner obtain a permit in order to use groundwater is inconsistent with the maxim “to whomsoever the soil belongs, he owns also to the sky and to the depths”).

183. *Cook v. Tracy*, 313 P.2d 803, 803 (Utah 1957).

184. 3 WATERS AND WATER RIGHTS, *supra* note 177, § 21.01, at 21–5.

theory,¹⁸⁵ in that ownership of the surface carries with it a defined entitlement to groundwater.

In summary, today most states reject the center of the earth approach to groundwater ownership.¹⁸⁶ It arguably survives only in the few jurisdictions that follow the correlative rights theory. Groundwater decisions do occasionally refer to the *ad inferos* maxim or to center of the earth ownership, but usually in the context of explaining that the absolute ownership theory is obsolete.

b. Oil and Gas

Under the center of the earth theory, owner A would own the oil and gas underlying his land surface, just as his neighbor B would hold title to the oil and gas beneath her land. Thus, if A operated an oil well that first withdrew the oil from under his land, and then also removed the oil from B's subsurface, A would be liable to B in damages. But the principles governing ownership of oil and gas effectively reject this center of the earth approach.¹⁸⁷ Much like the framework regulating groundwater, the basic rule is that property rights in oil and gas are acquired only by capture—that is, by removing them from the ground and thus converting them into personal property.

In the 1889 decision of *Westmoreland & Cambria Natural Gas Co. v. DeWitt*,¹⁸⁸ one of the first appellate cases to address the issue, the Pennsylvania Supreme Court reasoned that oil and natural gas were much like fugitive wild animals. Accordingly, possession of the land surface was “not necessarily possession of the [underlying] gas . . . [because if] an adjoining . . . owner, drills his own land, and taps your gas, so that it comes

185. See *City Mill Co. v. Honolulu Sewer & Water Comm'n*, 30 Haw. 912, 924 (1929) (noting that the correlative rights doctrine is “[a] much closer approach to adherence to the ancient maxim . . . that he who owns a piece of land owns it to the center of the earth”).

186. A related issue is whether a landowner is liable in tort if the removal of groundwater from his land causes physical injury to the land of another. Although the center of the earth theory would suggest that an owner may do anything he wishes with the subsurface, most courts would apply nuisance principles in this situation. See, e.g., *Henderson v. Wade Sand & Gravel Co.*, 388 So. 2d 900 (Ala. 1980) (applying nuisance law where groundwater removal during operation of the defendant's quarry caused sinkholes that damaged the plaintiffs' houses).

187. *Gray-Mellon Oil Co. v. Fairchild*, 292 S.W. 743 (Ky. Ct. App. 1927), symbolizes the judicial inconsistency about the center of the earth theory: “The [surface] owner in fee owns to the center of the earth. But he does not own a specific cubic foot of water, oil, or gas under the earth until he reduces it to possession.” *Id.* at 745.

188. 18 A. 724 (Pa. 1889).

into his well and under his control, it is no longer yours, but his.”¹⁸⁹ As another court later explained, “[r]igid adherence to the [center of the earth] doctrine would have exposed the landowner to liability for wrongful taking of oil and gas.”¹⁹⁰ It was accordingly necessary to jettison that doctrine.

Consistent with the capture rule, some states follow the “nonownership” theory with respect to oil and gas.¹⁹¹ Under this view, surface owner A enjoys a right to remove oil and gas from beneath his property, but does not own those resources until they are captured.¹⁹² Of course, if A’s neighbor B uses wells on her property to withdraw all the oil and gas from beneath A’s land before A exercises his right, then A has no claim against B. Just as a fisherman has a license to seek fish—rather than title to any particular fish—A merely has a right to hunt for oil, not title to oil.¹⁹³ A few states modify this approach by giving the surface owner a right to sue to prevent injury to or waste of subsurface oil and gas reservoirs, but similarly provide that the owner does not hold title to those minerals.¹⁹⁴

The other main approach—followed by a majority of states—is the confusingly named “ownership-in-place” theory.¹⁹⁵ This theory views oil and gas as part of the real property underlying the land surface, and thus as “owned” by the surface owner.¹⁹⁶ But this supposed ownership is purely rhetorical, because the oil and gas underlying the land of any surface owner may be freely captured by others, just as in nonownership jurisdictions.¹⁹⁷ As one treatise notes, the “ownership-in-place” approach has been criticized as “contrary to the essential characteristic of ownership, viz., the right of an

189. *Id.* at 725. In the same vein, another court criticized the idea that the surface owner owned the natural gas under his land as being so “unreasonable and untenable as to say that the air and the sunshine which float over the owner’s land is a part of the land, and is the property of the owner of the land.” *State v. Ohio Oil Co.*, 49 N.E. 809, 812 (Ind. 1898).

190. *Knighton v. Texaco Producing, Inc.*, 762 F. Supp. 686, 689 (W.D. La. 1991).

191. See generally RICHARD W. HEMINGWAY, *THE LAW OF OIL AND GAS* 32–33 (3d ed. 1991); 1 HOWARD R. WILLIAMS & CHARLES J. MEYERS, *OIL AND GAS LAW* § 203.1 (2002).

192. See, e.g., *Cont’l Res. of Ill., Inc. v. Ill. Methane, LLC*, 847 N.E.2d 897, 901 (Ill. App. Ct. 2006) (“Oil and gas are incapable of ownership until actually found and produced.”).

193. See HEMINGWAY, *supra* note 191, at 27 (noting that the surface owner merely holds “a right to search for and reduce the oil and gas to possession”).

194. See *id.*

195. See generally *id.* at 29–31; WILLIAMS & MEYERS, *supra* note 191, at § 203.3.

196. Indeed, this view has been called “an adaptation of the common law maxim *cujus est solum, ejus est usque ad coelum et ad inferos*.” HEMINGWAY, *supra* note 191, at 30.

197. See 6 THOMPSON ON REAL PROPERTY, *supra* note 63, at 240. As one treatise summarizes: Under this rule, absent some state regulation of drilling practices, a landowner, however small his tract and wherever located . . . may drill as many wells on his land as he pleases and at such locations as meet his fancy and is not liable to adjacent landowners whose lands are drained as a result of such operations.

WILLIAMS & MEYERS, *supra* note 191, at § 204.4.

owner to follow and to re-acquire his property from one who has removed it without permission.”¹⁹⁸ Thus, “ownership in place” is not ownership at all.

Today these common law rules are increasingly modified by statutes that promote governmental intervention in oil and gas production at the expense of traditional property rights. For example, in oil and gas regions it is common to inject salt water or other liquids into the subsurface in order to create underground pressure that facilitates oil or gas production.¹⁹⁹ But federal law prohibits the surface owner from drilling an injection well for this purpose without a special permit;²⁰⁰ thus, access to the subsurface is controlled by government. Similarly, statutes in many states provide for the “pooling” or “unitization” of parcels owned by different surface owners in order to create a more efficient system for oil or gas production, sometimes over the objection of certain owners.²⁰¹ As one Louisiana court noted, these statutes effectively amend the “general concept of ownership of the subsurface by the surface owner of the land” because that owner cannot “rely on a concept of individual ownership to thwart the common right to the resource.”²⁰²

c. Hard Rock Minerals

Comprehensive mining laws were first adopted in the United States during the nineteenth century, based largely on local mining customs.²⁰³ Broadly speaking, judicial decisions discussing ownership of hard rock minerals tend to assume that the area is governed by the center of the earth theory, even though the deepest mine in the United States extends

198. HEMINGWAY, *supra* note 191, at 32. One early scholar expressed the same critique in more pointed language, noting that using an absolute ownership approach to justify capturing the oil and gas of another

forms an anomalous exception that destroys the principle itself, forms a rule violative of the plainest principles of justice and equity, acknowledges the weakness of the law to enforce defined rights of property, and makes that relic of barbarism, “The simple plan, That they should take who have the power, And they should keep who can,” the basis of the law of property in oil and gas.

W.L. Summers, *Property in Oil and Gas*, 29 YALE L.J. 174, 179 (1919).

199. See Ana Boswell Schepens, Comment, *Prospecting for Oil at the Courthouse: Recovery for Drainage Caused by Secondary Recovery Operations*, 50 ALA. L. REV. 603, 607–08 (1999).

200. 40 C.F.R. § 144.31(a) (2006).

201. See, e.g., CAL. PUB. RES. CODE § 3321 (West 2001); GA. CODE ANN. § 12-4-45 (2001).

202. *Nunez v. Wainoco Oil & Gas Co.*, 488 So. 2d 955, 964 (La. 1986). However, where pooling or unitization does occur, whether by agreement or by compulsion, the result tends to be a more equitable distribution of revenues from oil or gas production, often taking into account the size of each surface parcel. See generally W.L. SUMMERS, 1 THE LAW OF OIL AND GAS §§ 5.1–5.54 (3d ed. 2004).

203. See 1 CURTIS H. LINDLEY, LINDLEY ON MINES § 10 (2d ed. 1903).

downward only about 1.5 miles.²⁰⁴ Accordingly, decisions often state or imply that the surface owner holds title to all gold, silver, coal, and other hard rock minerals underneath his land.²⁰⁵ However, there are significant exceptions to this approach.

One key exception is the doctrine of extralateral rights. Most hard rock mining operations in the United States are based on mining claims to public lands. Under federal law, property rights in minerals on these lands are governed by the underground structure of the mineral deposit, not by who holds a mining claim to the subsurface.²⁰⁶ Thus, for example, if the top (or apex) of a gold vein is found on A's mining claim, then A has the right to mine the entirety of the vein, even if it extends through B's adjacent claim; B has no right to recover the value of the gold that A removes from the subsurface.²⁰⁷ Early courts frankly recognized that the doctrine deviated from center of the earth theory,²⁰⁸ but defended it as necessary to promote mineral production.²⁰⁹ It was eventually codified as federal law governing mining claims on public lands.²¹⁰

In a similar fashion, federal, state, and local laws restrict the ability of a landowner to mine even on wholly private lands.²¹¹ For example, federal

204. The deepest mine in the United States is the now-closed Homestake Mine in South Dakota, which reached a depth of 2438 meters, or just over 8000 feet (1.52 miles). John Excell, *Underground Research: Depth of Knowledge*, ENGINEER, Sept. 17, 2007, at 20.

205. See, e.g., *Shell Oil Co., Inc. v. Moore*, 48 N.E.2d 400, 402 (Ill. 1943); *Toth v. Bigelow*, 64 A.2d 62, 64 (N.J. 1949).

206. 30 U.S.C. § 26 (2000).

207. See generally 2 AMERICAN LAW OF MINING § 37.01 (Cheryl Outerbridge ed., 2d ed. 2007); John C. Lacy, *The Historic Origins of the U.S. Mining Laws and Proposals for Change*, 10 NAT. RESOURCES & ENV'T 13, 16–19 (1995).

208. In fact, the extralateral rights doctrine apparently stems from mining customs in England that date from the thirteenth century. Lacy, *supra* note 207, at 15.

209. See, e.g., *Bullion Mining Co. v. Croesus Gold & Silver Mining Co.*, 2 Nev. 168, 178 (1866) (explaining that “[t]he doctrine of the common law, that he who has a right to the surface of any portion of the earth, has also the right to all beneath and above that surface, has but a limited application to the rights of miners,” because to “adhere to the common law rules on this subject is simply impossible”); see also *Collins v. Bailey*, 125 P. 543, 548 (Colo. Ct. App. 1912) (discussing deviation from the center of the earth theory); *Parrot Silver & Copper Co. v. Heinze*, 64 P. 326, 329 (Mont. 1901) (same, except using phrase *usque ad coelum et ad orbem*); *Fitzgerald v. Clark*, 42 P. 273, 282 (Mont. 1895) (same, except using phrase *ad coelum et ad orbem*).

210. 30 U.S.C. § 26; see also 30 U.S.C. § 27 (providing similar right to veins or lodes of minerals located within 3000 feet of a mine tunnel).

211. For example, local zoning laws may ban all mining activities in certain areas. See, e.g., *Gernatt Asphalt Prods., Inc. v. Town of Sardinia*, 664 N.E.2d 1226 (N.Y. 1996) (upholding an ordinance that eliminated mining as a permitted use). Similarly, state environmental statutes may impose other hurdles, such as prohibiting mining that may have a significant adverse impact on the natural environment. See, e.g., CAL. PUB. RES. CODE § 21080 (West 2007) (requiring the preparation of an environmental impact report for any privately owned project that requires discretionary governmental approval if the project might have an adverse impact on the environment);

statutes prohibit any surface or subsurface coal mining on private property unless the owner obtains a special permit—much like federal regulation of oil and gas drilling.²¹² The surface owner who cannot meet the permit standards will be unable to remove coal.²¹³ In fact, surface coal mining may be completely barred on certain types of private land, including: (1) environmentally sensitive regions; (2) lands with historical, cultural, or scientific resources; (3) areas that present natural hazards; and (4) lands used for food production or as watersheds.²¹⁴ Thus, despite the center of the earth theory, an owner may be legally unable to extract the coal immediately under the land surface.

d. Objects Embedded in the Soil

The traditional rule was that lost objects found embedded in the soil on private land belonged to the landowner, not to the finder—consistent with the *ad inferos* approach.²¹⁵ For example, in *Allred v. Biegel*,²¹⁶ a 1949 Missouri court awarded an ancient canoe to the owner of the land under which it was found, relying on an almost identical English decision that utilized the center of the earth theory.²¹⁷

However, in recent decades, about half of the states have enacted statutes that abandon this approach.²¹⁸ Although these statutes vary somewhat, the general pattern is clear: The finder is required to deliver the found object to a local law enforcement agency, with the hope that an advertisement will

id. § 21081 (prohibiting the approval of private projects that cause adverse environmental impacts that cannot be mitigated, absent special circumstances).

212. 30 U.S.C. § 1256 (requiring a permit for surface coal mining); *id.* § 1266(b) (requiring a permit for underground coal mining).

213. See, e.g., 30 C.F.R. § 773.4(a) (2007) (setting permit standards for surface mining). Federal regulations impose extensive conditions on coal mining, particularly on surface mining. For example, the applicant for a surface mining permit must provide a practical plan to (1) restore the land to its original use or a better use after the completion of the mining, see *id.* § 715.13; (2) protect topsoil in the mine area, see *id.* § 715.16; and (3) preserve the integrity of the regional hydrological system, see *id.* § 715.17.

214. *Id.* §§ 762.1–762.11.

215. See, e.g., *Bishop v. Ellsworth*, 234 N.E.2d 49 (Ill. App. Ct. 1968) (recognizing the rule in dispute concerning money found inside a jar partially embedded in soil); *Burdick v. Chesebrough*, 88 N.Y.S. 13 (App. Div. 1904) (earthenware); cf. *State v. David*, 1 Del. Cas. 160 (1797) (apparently using the Latin version of the maxim in a criminal case to show that the landowner was in possession of stolen goods because they were buried on his land).

216. 219 S.W.2d 665 (Mo. Ct. App. 1949).

217. *Elwes v. Brigg Gas Co.*, (1886) L.R. 33 Ch. D. 562 (holding that the surface owner also owned a 2000-year-old boat discovered underground).

218. See, e.g., N.Y. PERS. PROP. LAW §§ 251–257 (McKinney 1992); cf. CAL. CIV. CODE §§ 2080–2080.3 (West 2007).

allow the true owner to step forward and claim his property.²¹⁹ If no one claims the object within a set period, it becomes the property of the finder, not the landowner.

Similarly, the center of the earth theory is increasingly rejected in the specialized context of Native American artifacts. In most states, a private landowner has no right to disturb Native American burial sites located on or under the surface.²²⁰ When such a site is discovered, statutes usually require that the discovery be reported to a public official, that any construction activities cease, and that appropriate measures be taken for reburial of human remains, either on site or elsewhere.²²¹ Moreover, in some jurisdictions any Native American grave artifacts found on private land belong to either the appropriate tribe or the state, not the landowner.²²²

e. Waste Disposal

One potential use for deep subsurface areas is the disposal of chemical and industrial wastes. In the 1930s, certain oil companies began to dispose of various liquid oil and gas wastes by injecting them into underground wells.²²³ This practice was adopted over time by other industries,²²⁴ leading to injection wells over two miles deep.²²⁵ The logic of the center of the earth theory suggests that the surface owner should have the unfettered right to construct and operate such wells. However, since the 1980s, two

219. *Id.*

220. See Sherry Hutt & C. Timothy McKeown, *Control of Cultural Property as Human Rights Law*, 31 ARIZ. ST. L.J. 363, 376 (1999). In addition, state environmental laws may prevent the excavation of sites containing Native American artifacts or other historical items. For example, under California law an environmental impact report is required for private projects that may have a significant adverse impact on the environment. CAL. PUB. RES. CODE § 21080 (West 2007). "Environment" in this context includes "the physical conditions which exist within the area which will be affected by a proposed project, including . . . objects of historic . . . significance." *Id.* § 21060.5. A project that has adverse impacts on historic resources may be prohibited. See, e.g., *Uphold Our Heritage v. Town of Woodside*, 54 Cal. Rptr. 3d 366 (Ct. App. 2007) (prohibiting the demolition of a historic mansion).

221. See, e.g., FLA. STAT. ANN. § 872.05(1)–(4) (West 2000); NEB. REV. STAT. §§ 12-1205, 12-1208 (2006); see also David J. Harris, Note, *Respect for the Living and Respect for the Dead: Return of Indian and Other Native American Burial Remains*, 39 WASH. U. J. URB. & CONTEMP. L. 195, 213–18 (1991) (collecting state statutes).

222. See, e.g., ALA. CODE § 41-3-1 (2000) (property of state). But see N.M. STAT. ANN. § 18-6-11.2G (West 2004) (allowing the landowner to keep artifacts under certain conditions).

223. ENVTL. PROT. AGENCY, CLASS I UNDERGROUND INJECTION CONTROL PROGRAM: STUDY OF THE RISKS ASSOCIATED WITH CLASS I UNDERGROUND INJECTION WELLS 5 (2001), http://www.epa.gov/safewater/uic/pdfs/study_uic-class1_study_risks_class1.pdf.

224. See *id.*

225. *Id.* at 12.

federal statutes—the Resource Conservation and Recovery Act²²⁶ and the Safe Drinking Water Act²²⁷—have increasingly restricted this practice.²²⁸ Today, a landowner may not use a well to inject any liquid or gas under her land without a special permit from the federal government or, in some instances, an authorized state agency.²²⁹ In effect, the government licenses access to the subsurface for this purpose.²³⁰

This regulatory program is flatly inconsistent with the center of the earth theory, because many owners will be unable to satisfy the permit requirements.²³¹ For instance, even if an owner meets all other permit requirements, the subsurface injection of various hazardous substances is prohibited²³² unless the owner also qualifies for a special exemption.²³³ To secure the exemption, the owner must prove that there will be “no migration” of hazardous materials from the injection area “for as long as the waste remains hazardous.”²³⁴ This standard requires the owner to establish, among other things, that for 10,000 years the hazardous wastes will not migrate either (1) vertically out of the injection zone; or (2) laterally to interface with an underground aquifer that is suitable for use as a supply of drinking water.²³⁵ In part because of the difficulty of meeting this standard, there are only 123 hazardous waste injection wells in the United States.²³⁶

226. 42 U.S.C. §§ 6901–6992 (2000).

227. *Id.* §§ 300f–300j.

228. See generally Earle A. Herbert, *The Regulation of Deep-Well Injection: A Changing Environment Beneath the Surface*, 14 PACE ENVTL. L. REV. 169, 190–98 (1996); see also JOHN G. SPANKLING & GREGORY S. WEBER, *THE LAW OF HAZARDOUS WASTES AND TOXIC SUBSTANCES IN A NUTSHELL* 220–22, 234–42 (2d ed. 2007) (discussing the impact of the Resource Conservation and Recovery Act on land disposal of hazardous wastes).

229. 40 C.F.R. § 144.11 (2006). The prohibition extends to “any material or substance which flows or moves whether in semisolid, liquid, sludge, gas, or any other form or state.” *Id.* § 144.3; see, e.g., *Sunoco Partners Mktg. & Terminals LP v. EPA*, No. 05-74742, 2006 U.S. Dist. LEXIS 2817 (E.D. Mich. Jan. 20, 2006) (rejecting a landowner’s application for a preliminary injunction against the EPA’s approval of a hazardous waste injection well project on an adjacent parcel); *Chance v. BP Chems., Inc.*, 670 N.E.2d 985 (Ohio 1996) (involving a chemical refining plant whose employees disposed of hazardous wastes by using injection wells authorized by permits from the Ohio and U.S. Environmental Protection Agencies).

230. Similarly, federal law bars a property owner from placing any “noncontainerized or bulk liquid hazardous waste” in any mine, cave, salt dome formation, or salt bed formation. 40 C.F.R. § 264.18 (c).

231. See, e.g., *Hunter Indus. Facilities, Inc. v. Tex. Natural Res. Conservation Comm’n*, 910 S.W.2d 96 (Tex. App. 1995) (upholding the denial of permits for injection wells and related facilities); *United Res. Recovery, Inc. v. Tex. Water Comm’n*, 815 S.W.2d 797 (Tex. App. 1991) (same).

232. See 40 C.F.R. §§ 148.11–148.18.

233. *Id.* § 148.20(a).

234. *Id.*

235. *Id.* § 148.20(a)(1)(i).

236. See ENVTL. PROT. AGENCY, *supra* note 223, at 3.

f. Occupying the Subsurface

Even if the law constrains the ability of a landowner to derive economic profit from the subsurface, one might still ask: Can the surface owner at least occupy it? For example, could the surface owner dig a mile-deep hole on her land and construct a small dwelling at the bottom, thereby asserting her theoretical ownership?²³⁷

A multitude of legal barriers would probably derail any such effort. First, most jurisdictions would require that the owner obtain a grading permit before any digging began, because “excavation” is viewed as one type of “grading.”²³⁸ In order to obtain a grading permit for a project of such magnitude, the owner would have to demonstrate the safety of the project by submitting a soils engineering report and potentially a liquefaction study.²³⁹ In some jurisdictions, the excavation would also trigger review under the appropriate environmental impact review system, potentially requiring the preparation of an environmental impact report.²⁴⁰ Depending on the results from these various reports, the project might well be disallowed by local officials. Even if the proposed excavation passed regulatory review, the landowner might be dissuaded from proceeding by the risk of tort liability

237. Admittedly, some unusual uses are uniquely suited to the subsurface. The National Science Foundation plans to construct a Deep Underground Science and Engineering Laboratory within the now-closed Homestake gold mine in South Dakota, the deepest mine in the United States, in order to conduct experiments relating to astrophysics and astronomy away from the cosmic rays and other radiation that strikes the earth's surface. See Excell, *supra* note 204. One portion of the laboratory will be 7400 feet below the surface, making it the deepest laboratory in the world, and probably the deepest structure occupied by humans in the United States. *Id.* Even at the comparatively shallow 8000 foot depth of the mine, the temperature is already 57°C—while federal standards recommend that no worker be exposed to workplace heat of over 40°C. *Id.*; see also *infra* note 292.

238. See, e.g., Int'l Code Council, INT'L BLDG. CODE app. J §§ J102.1, J103.1–2 (2006) (requiring grading permit generally for any “excavation or fill or combination thereof,” but providing exceptions for certain types of excavations, none of which apply here).

239. *Id.* §§ J104.3–4.

240. As noted above, see *supra* note 220, California law requires the preparation of an environmental impact report for any private project that might have a significant adverse effect on the environment. CAL. PUB. RES. CODE § 21080(a) (West 2007). The construction of a shaft one mile deep would raise at least three concerns: (1) potential injury to groundwater resources; (2) noise and traffic impacts from the excavation process; and (3) possible damage caused by the disposal of excavation wastes. For instance, assuming a simple shaft merely twenty feet wide and twenty feet broad, this would produce over 74,000 cubic yards of excavation wastes; how would they be dealt with? In *Day v. City of Glendale*, 124 Cal. Rptr. 569 (Ct. App. 1975), the court held that an environmental impact report was required for a grading project that involved the excavation of 343,000 cubic yards of soil. In like manner, a similar report logically would be required for the hypothetical shaft. See also *No Oil, Inc. v. City of Los Angeles*, 242 Cal. Rptr. 37 (Ct. App. 1987) (discussing the adequacy of an environmental impact report for a project to drill exploratory oil wells downward for 10,000 feet).

stemming from her duty to provide lateral support to neighboring lands, her duty to avoid undue injury to the groundwater table, or other obligations. Of course, local zoning ordinances conceivably might prohibit any excavation at all.²⁴¹ More fundamentally, even if the hole could be dug, the detailed requirements of the standard building code would render construction of a dwelling virtually impossible absent a variance.²⁴²

2. The Right to Exclude

At common law, a landowner held a virtually absolute right to exclude others from his land. Even today, as the Supreme Court has observed, the right to exclude is “one of the most essential sticks in the bundle of rights that are commonly characterized as property.”²⁴³ Consistent with this view, American courts have routinely found a trespass for intentional physical intrusions in the near-surface zone.²⁴⁴ Typical examples include building foundations, tree roots, or pipe lines that extend from land owned by A into land owned by B, almost always within one hundred feet of the surface.²⁴⁵

This absolutist common law right evolved in cases concerning surface intrusions. Blackstone observed that every person’s land was “inclosed and set apart from his neighbor’s . . . either by a visible and material fence, as one field is divided from another by a hedge; or, by an ideal, invisible boundary . . . as when one man’s land adjoins to another’s in the same field.”²⁴⁶ Thus, Blackstone’s fence, whether tangible or imaginary, only spanned the

241. An example is *Krantz v. Town of Amherst*, 80 N.Y.S.2d 812 (Sup. Ct. 1948), where the court upheld the validity of an ordinance that prohibited an owner from removing the topsoil from land zoned for agriculture. The court reasoned that “the old absolute ownership from the center of the earth *usque a coelum* has given way to a variety of new needs and to a broadened concept of duty to neighbors.” *Id.* at 817; see also *Goldblatt v. Town of Hempstead*, 369 U.S. 590 (1962) (upholding an ordinance that limited the depth of excavation); 1 ZONING AND LAND USE CONTROLS § 6.02[2] (Patrick J. Rohan & Eric Damian Kelly eds., 2007) (generally discussing underground zoning ordinances).

242. See, e.g., INT’L BLDG. CODE § 1007 (“accessible means of egress”); *id.* § 1024 (“exit discharge”) (2006).

243. *Kaiser Aetna v. United States*, 444 U.S. 164, 176 (1979); see also Thomas W. Merrill, *Property and the Right to Exclude*, 77 NEB. L. REV. 730 (1998).

244. One of the best known—and deepest—intrusions of this type is found in *Edwards v. Lee’s Administrators*, 96 S.W.2d 1028 (Ky. 1936), involving the Great Onyx Cave, which is noted for its rock crystal formations 360 feet below the surface.

245. See *supra* notes 161–162 and accompanying text. But see *First Unitarian Soc’y v. Citizens’ Sav. & Trust Co.*, 142 N.W. 87 (Iowa 1913) (finding no breach of warranty against encumbrances based on the presence of a public sewer pipe six feet below the land surface, despite the dissent’s plea that “hombok law” states that the surface owner’s rights extend to the center of the earth).

246. 3 BLACKSTONE, *supra* note 6, at *209–10.

land surface. In this setting, it was perhaps logical to insist on the surface owner's near-absolute right to exclude others in order to maximize the productive use of land.²⁴⁷

However, the handful of decisions involving the surface owner's right to exclude in the deep subsurface reveal quite a different pattern.²⁴⁸ Increasingly, modern courts restrict or ignore this theoretical right, as reflected in a series of cases concerning (a) oil and gas operations; and (b) migrating wastes.²⁴⁹ Accordingly, as the Ohio Supreme Court explained while rejecting a trespass claim based on events that occurred about 2800 feet deep, it is appropriate to extend the concept "that absolute ownership of air rights is a doctrine which 'has no place in the modern world,' to apply as well to ownership of deep subsurface rights."²⁵⁰

a. Oil and Gas Operations

Oil and gas companies routinely inject liquids into the subsurface to enhance oil and gas production, as noted above.²⁵¹ Suppose A injects salt water 2000 feet below his land in order to boost oil recovery. When the injected water foreseeably migrates underneath the land surface owned by B, can B sue A in trespass?

Logically, the center of the earth theory should allow B to exclude A's injectate. An actor is liable for trespass if he intentionally "enters land in the possession of the other, or causes a thing . . . to do so," regardless of whether it causes any harm.²⁵² In this context, "intent" merely means "knowledge that

247. See generally RICHARD A. POSNER, *ECONOMIC ANALYSIS OF LAW* 32–34 (6th ed. 2003).

248. Most authorities suggest that the owner's right to exclude others from the subsurface is equally as strong as his right to exclude others from the surface. See, e.g., RESTATEMENT (SECOND) OF TORTS § 159(1) (1965) (stating that except as limited by subsection 2, dealing with airspace, "a trespass may be committed on, beneath, or above the surface of the earth"); HARPER ET AL., *supra* note 66, § 1.5 ("It is a trespass to make an entry below the surface of another's land for any reason not justifiable as an entry on the surface."). But see DAN B. DOBBS, *THE LAW OF TORTS* § 55, at 112 (2000) ("A tunnel hundreds of feet below the surface that does not affect the value of the land or remove minerals probably should not be regarded as a trespass.").

249. The same tendency to restrict the right to exclude in the deep subsurface occasionally appears in other contexts. See, e.g., *Bd. of County Comm'rs v. Park County Sportsmen's Ranch, LLP*, 45 P.3d 693, 710 (Colo. 2002) ("We reject the Landowners' claim that the *cujus* doctrine provides them with a property right to require consent for artificial recharge and storage of water in aquifers that extend through their land."); *Boehringer v. Montalto*, 254 N.Y.S. 276 (Sup. Ct. 1931) (finding that an easement for a sewer over 150 feet below the surface did not breach the grantor's warranty against encumbrances, because it would not affect the grantee's use of land).

250. *Chance v. BP Chems., Inc.*, 670 N.E.2d 985, 992 (Ohio 1996).

251. See *supra* note 199 and accompanying text.

252. RESTATEMENT (SECOND) OF TORTS § 158; see also DOBBS, *supra* note 248, § 50 (discussing the elements of trespass to land).

[an act] will to a substantial certainty result in the entry of the foreign matter.”²⁵³ If A injects salt water knowing that it will eventually enter strata underneath the surface owned by B, this would seem to constitute a trespass.

But a number of decisions refuse to impose trespass liability in this situation, especially where A’s action is either authorized by a state agency or located within a unitized production zone.²⁵⁴ The foundation for these decisions is the public policy encouraging oil and gas production, which outweighs an owner’s traditional right to exclude. As the Texas Supreme Court explained in one case, “[t]he orthodox rules and principles applied by the courts as regards surface invasions of land may not be appropriately applied to subsurface invasions as arise out of the secondary recovery of natural resources.”²⁵⁵ This approach is sometimes characterized as a “negative rule of capture.”²⁵⁶

A few decisions have extended this principle even to physical intrusions by drilling equipment.²⁵⁷ For example, in *Nunez v. Wainoco Oil & Gas Co.*,²⁵⁸ the plaintiff relied on the center of the earth theory to argue that a trespass occurred when the defendant oil company drilled a bore that first reached his land at a point about two miles below the surface in a unitized oil field. But the Louisiana Supreme Court rejected this claim on the basis that the statutes authorizing unitization superseded the “general concept of ownership of the subsurface by the surface owner of the land.”²⁵⁹

b. Migrating Wastes

Suppose that A disposes of liquid wastes by injecting them deep beneath her land; over time, the wastes foreseeably migrate into a zone under B’s land

253. RESTATEMENT (SECOND) OF TORTS § 158 cmt. i.

254. See, e.g., *Raymond v. Union Tex. Petroleum Corp.*, 697 F. Supp. 270 (E.D. La. 1988); *Baumgartner v. Gulf Oil Corp.*, 168 N.W.2d 510 (Neb. 1969); *West Edmond Salt Water Disposal Ass’n v. Rosecrans*, 226 P.2d 965 (Okla. 1950); *R.R. Comm’n v. Manziel*, 361 S.W.2d 560 (Tex. 1962); cf. *Boudreaux v. Jefferson Island Storage & Hub, LLC*, 255 F.3d 271 (5th Cir. 2001) (finding no trespass where the state authorized the defendant to dispose of waste salt water one mile below the surface, even though the injectate migrated under the plaintiff’s land).

255. *Manziel*, 361 S.W.2d at 568; see also HEMINGWAY, *supra* note 191, at 212 (suggesting that “it would seem more desirable to classify the intrusion into the adjoining sub-surface as a trespass that was not actionable due to overriding public policy,” rather than to hold, as the *Manziel* court did, that no trespass had occurred).

256. See *Schepens*, *supra* note 199, at 608.

257. See, e.g., *Cont’l Res., Inc. v. Farrar Oil Co.*, 559 N.W.2d 841, 846 (N.D. 1997) (holding that a statute authorizing pooling superseded a lessee’s right to prevent another from drilling an oil well through his leased land and, accordingly, “the property law of trespass” was inapplicable).

258. 488 So. 2d 955 (La. 1986).

259. *Id.* at 964.

surface. Although the center of the earth approach should allow B to exclude those wastes—or at least receive compensation for trespass—many courts²⁶⁰ provide no relief to the surface owner like B.²⁶¹

The leading case is *Chance v. BP Chemicals, Inc.*,²⁶² in which the defendant chemical company disposed of liquid wastes by injecting them into a sandstone formation about 2800 feet deep. The plaintiffs brought a class action on behalf of over 20,000 surface owners, raising trespass,²⁶³ nuisance, and other claims stemming from the underground migration of the wastes four or five miles in each direction. On appeal following a defense verdict, the plaintiffs argued that “[t]he owner of land has absolute ownership of all the subsurface property,” relying on the familiar *ad inferos maxim*.²⁶⁴ But the court flatly rejected this absolutist claim, noting that “ownership rights in today’s world are not so clear-cut as they were before the advent of airplanes and injection wells.”²⁶⁵ Rather, analogizing to the airplane cases that restricted the *ad coelum* doctrine, it reasoned that “there are also limitations on property owners’ subsurface rights.”²⁶⁶ Accordingly, the court held that the plaintiffs could only “exclude invasions of the subsurface property that actually interfere with [their] reasonable and foreseeable use of the subsurface.”²⁶⁷ Under this standard, the mere presence

260. See, e.g., *FPL Farming, Ltd. v. Tex. Natural Res. Conservation Comm’n*, No. 03-02-00477-CV, 2003 WL 247183, at *4 (Tex. App. Feb. 6, 2003) (dismissing the surface owner’s objection to an injection well permit application on the basis that the injection of wastewater about 8000 feet deep would not cause injury to the owner’s “existing or intended use of the deep subsurface”).

261. In contrast, where pollution close to the surface directly interferes with surface uses—for example, by polluting groundwater used as drinking water by the surface owner—courts have typically provided relief. See, e.g., *The Stanley Works v. Snydergeneral Corp.*, 781 F. Supp. 659 (E.D. Cal. 1990) (granting recovery for an underground toxic plume over one hundred feet below the surface); *Miller v. Cudahy Co.*, 592 F. Supp. 976 (D. Kan. 1984) (holding that the saltwater contamination of an aquifer between ten and seventy feet deep was a nuisance); *Hoery v. United States*, 64 P.3d 214 (Colo. 2003) (en banc) (holding that the subsurface migration of toxic substances that contaminated a well eighty-four feet below the surface was both a trespass and a nuisance).

262. 670 N.E.2d 985 (Ohio 1996).

263. Some jurisdictions approach the issue by treating the subsurface intrusion of migrating wastes as an “indirect trespass,” thus requiring that the plaintiff establish “substantial actual damage” before trespass liability will attach. See, e.g., *Borland v. Sanders Lead Co.*, 369 So.2d 523, 529–30 (Ala. 1979).

264. *Chance*, 670 N.E.2d at 991 (internal quotation marks omitted).

265. *Id.* at 992.

266. *Id.*; see also *Mongrue v. Monsanto Co.*, No. CIV.A. 98-2531, 1999 WL 970354, at *4 (E.D. La. 1999) (using the *Chance* standard); *Bd. of County Comm’rs v. Park County Sportsmen’s Ranch*, 45 P.3d 693, 701 (Colo. 2002) (quoting the *Chance* standard with approval).

267. *Chance*, 670 N.E.2d at 992.

of the injectate within the plaintiffs' subsurface was not sufficient damage to sustain their trespass claim.

The *Chance* standard largely eviscerates a surface owner's right to exclude subsurface wastes. First, only those surface owners who are actively using the subsurface for a specific "reasonable and foreseeable" purpose are able to bring suit—a small minority. As between the idle owner of the subsurface, on the one hand, and an active intruder who devotes that subsurface to productive use, this approach favors the intruder. Second, even the rare surface owner who is actively using the subsurface has the burden of proving that the intruder has "actually interfered" with his use. Due to the complexity of subsurface geology, it will be extraordinarily difficult for any owner to make this factual showing. *Chance* itself demonstrates the problem: Even though plaintiffs presented expert testimony by a hydrogeologist, the court dismissed this evidence as "simply too speculative."²⁶⁸ Ultimately, *Chance* reflects a judicial mindset that views ownership rights in the deep subsurface as meaningless.

C. A Blank Slate

The discussion above establishes two key points. First, American law has never determined whether a landowner's rights extend more than two miles below the surface. Indeed, because the extent of property rights is a question of state law, the downward limit reflected in appellate decisions will vary significantly by jurisdiction—but will be less than two miles, perhaps much less, outside of Louisiana. Accordingly, we confront the proverbial blank slate in determining the extent of property rights below two miles.

Second, the law governing the owner's rights within two miles of the surface is largely inconsistent with the center of the earth theory. Judicial decisions and specialized statutes have so eroded the supposed rights of the surface owner that the few remaining fragments cannot legitimately be seen as title.²⁶⁹ In short, the exceptions have swallowed any theoretical rule.

268. *Id.* at 993. See also *Sunoco Partners Mktg. & Terminals, LP v. EPA*, No. 05-74742, 2006 U.S. Dist. LEXIS 2817, at *41 (E.D. Mich. Jan. 20, 2006) (denying an application for a preliminary injunction against an injection of hazardous wastes 4000 feet deep on the basis that the plaintiff could not demonstrate injury to its planned brine extraction project, because "it is not possible now to know for sure the extent to which hazardous wastes . . . would affect the brines").

269. Cf. RESTATEMENT OF PROPERTY § 10 cmt. c (1936) (implying that at some point the degree of loss of property rights might become so substantial that "ownership" no longer exists).

IV. TOWARD A NEW MODEL OF SUBSURFACE OWNERSHIP

A surface owner should logically hold some rights in the subsurface. At the most basic level, for instance, homeowner H should be entitled to occupy enough of the subsurface to accommodate the foundation for her house, tree roots, and other normal surface facilities. But how far downward should these rights extend?

Given the modern technological advances in potential subsurface uses, it is appropriate to consider a new model of subsurface ownership. Because humans have never penetrated below the crust, it is helpful to divide the analysis into two questions. First, should private ownership be recognized below the crust? Second, to what extent should private ownership be recognized within the crust?

In examining these questions, the evolution of airspace rights provides a useful, if inexact, parallel. Just as human activities in the subsurface have been confined to the crust, virtually all human activities in airspace have been limited to the earth's atmosphere. Under this approach, the inaccessible region below the crust is akin to the relatively inaccessible reaches of outer space. It is generally accepted that private property rights cannot exist in the moon and other celestial objects.²⁷⁰ For much the same reasons, it would be inappropriate to recognize property rights below the crust.

The scope of property rights within the crust poses a more difficult issue. The discussion below examines four alternative approaches to the question. Ultimately, this Article suggests that an owner's rights should extend only 1000 feet below the surface, with an exception for mineral rights.

A. Factors Affecting the Extent of Subsurface Ownership

As a general matter, the extent of property rights is necessarily determined by the justification for private property.²⁷¹ The dominant jurisprudential theory justifying American property law is traditional utilitarianism: the familiar idea that property exists to promote the

270. Article II of the Outer Space Treaty prohibits any nation from claiming sovereignty in the moon, the planets, or other celestial objects; if national sovereignty cannot exist there, by definition, private property rights cannot exist. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies art. II, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter 1967 Treaty].

271. See LAWRENCE C. BECKER, PROPERTY RIGHTS: PHILOSOPHIC FOUNDATIONS 1-6 (1977).

happiness of society as a whole.²⁷² During the twentieth century, courts relied on utilitarian considerations to justify abandonment of the *ad coelum* approach to airspace rights.²⁷³ In the same manner, a utilitarian analysis of five criteria²⁷⁴ suggests that private property rights should not extend deeper than the very shallow crust.²⁷⁵

1. Expectations

Jeremy Bentham, the father of utilitarianism, famously observed that property rights are premised on expectations: “Property is nothing but a basis of expectation.”²⁷⁶ In a similar fashion, modern courts and scholars have stressed the importance of societal expectations in defining the extent of property rights.²⁷⁷

Empirical research conducted for this Article indicates that most homeowners believe their rights extend only to the immediate subsurface below their homes. During June 2007, one hundred homeowners in Davis, California were asked: “How far below the surface does your property ownership extend?”²⁷⁸ As shown in the Appendix, 76 percent of the surveyed owners believed that their property rights extended no deeper than one hundred feet.²⁷⁹ Moreover, 85 percent indicated that their rights ended

272. See SPRANKLING, *supra* note 62, at 12, 16; see also *State v. Shack*, 277 A.2d 369, 372 (N.J. 1971) (“Property rights serve human values. They are recognized to that end, and are limited by it.”).

273. See *supra* notes 142–144 and accompanying text.

274. These criteria are largely adapted from those employed in the decisions that ended the “ownership to the heavens” prong of the *ad inferos* maxim. Other criteria, of course, may also be relevant. But see Steven D. McGrew, Note, *Selected Issues in Federal Condemnations for Underground Natural Gas Storage Rights: Valuation Methods, Inverse Condemnation, and Trespass*, 51 CASE W. RES. L. REV. 131, 176–79 (2000) (arguing that the evolution of rights in airspace is not applicable by analogy to subsurface disputes because subsurface rights are more valuable).

275. Admittedly, a number of other theories are generally relevant to American property jurisprudence, ranging from labor-desert theory to civic republican theory to natural law. See generally SPRANKLING, *supra* note 62, at 11–22. But each assumes that the object of property rights can be readily accessed by humans, like the surface of land or an item of tangible personal property. Because the deep subsurface is relatively inaccessible to humans, these other theories have little or no application to the discussion in this Subpart.

276. JEREMY BENTHAM, *THE THEORY OF LEGISLATION* 68 (Richard Hildreth trans., Oceana Publications, Inc. 1975) (1802).

277. See, e.g., *Penn Cent. Transp. Co. v. New York City*, 438 U.S. 104, 124 (1978) (noting that the “distinct investment-backed expectations” of the owner should be considered as one factor to determine if a regulatory taking has occurred); Craig A. Arnold, *The Reconstitution of Property: Property as a Web of Interests*, 26 HARV. ENVTL. L. REV. 281, 347–48 (2002); Thomas C. Grey, *The Malthusian Constitution*, 41 U. MIAMI L. REV. 21, 28 (1986).

278. The survey was conducted by having the homeowners fill out a card that contained the two multiple-choice questions set forth in the Appendix, see *infra* app., one on each side of the card.

279. See *infra* app.

within the crust.²⁸⁰ While this preliminary survey is far from conclusive,²⁸¹ it certainly suggests that most property owners do not expect to hold rights in the deep subsurface.²⁸²

These survey findings reflect a practical reality: The American vision of land ownership is almost exclusively concerned with surface rights. The average surface owner has no interest in events occurring in the deep subsurface because they do not affect his enjoyment of the surface.

2. Lack of Possession

One justification for overturning the *ad coelum* doctrine was that airspace “is in the actual possession of no one, . . . being incapable of such possession.”²⁸³ As the Ninth Circuit observed in an early air rights decision:

The first and foremost of these [elementary legal] principles is that the very essence and origin of the legal right of property is dominion over it. Property must have been reclaimed from the general mass of the earth, and it must be capable by its nature of exclusive possession. Without possession, no right in it can be maintained.²⁸⁴

In our common law tradition, physical possession has long been the touchstone of property rights,²⁸⁵ because only a person in possession can utilize land for the common good. This theme is evident even in Blackstone’s absolutist definition of property as “that sole and despotic dominion which one man claims and exercises over the external things of the world, in total

280. The average thickness of the continental crust is about twenty-two to twenty-five miles. See LUTGENS & TARBUCK, *supra* note 5. Eighty-five of the one hundred surveyed owners responded that their rights extended downward ten miles or less. See *infra* app.

281. Davis, California has the “highest level of education in the state with more than . . . 60% [of the adult population] having attained at least a four-year college degree.” City of Davis Profile, Population & Housing, <http://www.city.davis.ca.us/aboutdavis/cityprofile/index.cfm?topic=population> (last visited Sept. 20, 2007). Accordingly, the survey respondents may be more likely to know about the center of the earth theory—and thus have greater subsurface expectations—than most landowners elsewhere.

282. A satirical anecdote recounted by a North Carolina court points out the lack of public awareness of the *ad inferos* concept:

An Irish lawyer named Sullivan once argued an air rights case before the highest court of Great Britain. A member of the court asked during oral argument: “Mr. Sullivan, have your clients not heard of the maxim, *cujus est solum, ejus est usque ad coelum et ad inferos*?”

Sullivan responded: “My lords, the peasants of Northern Ireland speak of little else.”

Steel Creek Dev. Corp. v. James, 294 S.E.2d 23, 27 n.2 (N.C. Ct. App. 1982).

283. Thrasher v. City of Atlanta, 173 S.E. 817, 825 (Ga. 1934).

284. Hinman v. Pac. Air Transp., 84 F.2d 755, 758 (9th Cir. 1936).

285. See, e.g., Richard A. Epstein, *Possession as the Root of Title*, 13 GA. L. REV. 1221 (1979); Carol M. Rose, *Possession as the Origin of Property*, 52 U. CHI. L. REV. 73 (1985).

exclusion of the right of any other individual in the universe.”²⁸⁶ Of course, physical possession is necessary for the “exercise” of “dominion” that Blackstone contemplated. If the law recognizes property rights only in that which is capable of possession, then almost all airspace—and almost all subsurface areas—cannot be property.²⁸⁷

As applied to real property, Blackstone’s sweeping definition makes sense only in the context of surface and near-surface rights. Farmer F has an incentive to invest the time and money necessary to grow a crop on the land surface—thereby providing benefits to society at large—only if the legal system protects her possession by recognizing both (1) her right to use the land and (2) her right to exclude others.²⁸⁸ Absent this protection, F’s crop would be vulnerable to any passing stranger. English common law accordingly developed a robust system of private property rights in land, based on the importance of protecting actual possession of the land surface.

Like airspace, almost all of the deep subsurface is unpossessed. The deepest point that humans have physically occupied in the United States is a gold mine shaft that extends about 1.5 miles down.²⁸⁹ A number of injection wells and oil wells reach beyond this point, but it is not clear that these activities should be viewed as possession. Indeed, in cases like *Chance v. BP Chemicals, Inc.*,²⁹⁰ courts seem to suggest that the surface owner is not in possession of the deep subsurface so as to justify a trespass action based on the migration of waste fluids from another injection’s well.²⁹¹ Even these shallow penetrations are exceptional. Under the vast majority of the land surface of the United States, the extent of human penetration is extremely small, usually less than one hundred feet.

Similarly, the deep subsurface is largely incapable of possession in the traditional sense. Due to extremes of pressure and temperature, human access to this region is impractical, as discussed above in Part II. The temperature of over 500°C at the crust-mantle boundary, for example, would kill a human in a few moments. Federal standards governing the

286. 2 BLACKSTONE, *supra* note 6, at *2.

287. See JOHN G. FLEMING, THE LAW OF TORTS 45 (2d ed. 1961) (noting that “it is questionable whether the surface owner is protected with respect to claims over subterranean areas which he is unable to subject to his dominion”).

288. See generally POSNER, *supra* note 247, at 32–34.

289. See Excell, *supra* note 204, at 20.

290. 670 N.E.2d 985 (Ohio 1996).

291. *Chance* and its progeny appear to repudiate the idea that the surface owner has sufficient possession of the subsurface to maintain a trespass action, unless that owner has an actual or foreseeable “use” of that subsurface region; the implication is that the surface owner may acquire possession only by actual use. See *id.*

maximum temperature for worker safety effectively prohibit human labor below about two miles, absent unusual technology.²⁹² Of course, with special life support equipment, perhaps like that employed in space exploration, deeper human penetration of the subsurface is possible; and robotic equipment can presumably reach even lower levels.

Thus, our traditional view of private property rights in land implicitly assumes the “land” in question is the land surface and portions of the immediately adjacent airspace or subsurface necessary to facilitate surface use. Both the airspace and the subsurface surrounding this surface zone are typically unpossessed and largely incapable of possession.

As a general rule, our property law system prefers private ownership over public ownership. Richard Posner has explained that efficiency is enhanced if “every valuable (meaning scarce as well as desired) resource were owned by someone,” which he calls the “criterion of universality.”²⁹³ However, almost all of the deep subsurface is not “valuable” in this sense. Comprising over 99 percent of the earth’s volume, it is not “scarce.” Similarly, because it cannot be productively possessed, it is generally not “desired.” Under these circumstances, some form of public ownership of the deep subsurface is appropriate.

3. Enforcement Difficulty

Legal positivism teaches that property rights exist only to the extent that they can be enforced by government.²⁹⁴ Accordingly, courts dealing with early cases of alleged airplane trespass expressed concern that it would be impossible to enforce private property rights in airspace. As one court summarized:

It would be, and is, utterly impracticable and would lead to endless confusion, if the law should uphold attempts of landowners to stake

292. The Occupational Health and Safety Act mandates that an employer must provide each employee with “employment and a place of employment which are free from recognized hazards that are capable of causing or are likely to cause death or serious physical harm to his employees.” 29 U.S.C. § 654(a) (2000). A workplace with excessive heat may violate this standard. See, e.g., *Sec’y of Labor v. Duriron Co., Inc.*, 11 O.S.H. Cas. (BNA) 1405 (O.S.H.R.C. 1983) (finding that temperature in foundry up to 115°F violated standard), *aff’d* 750 F.2d 28 (6th Cir. 1984). The National Institute for Occupational Safety and Health recommends that no worker be exposed to workplace heat levels in excess of 40°C. See NIOSH CRITERIA, *supra* note 91, at 2, 3, 14, 15. By analogy, the temperature in the deepest South African gold mines—about two miles deep—can reach 65°C; mining there is only possible with a combination of short shifts and extraordinarily powerful ventilation equipment. See Stephanie Pain, *The Intraterrestrials*, NEW SCIENTIST, Mar. 7, 1998, at 28. Within the United States, the temperature at a level two miles deep ranges from 50° to 150°C. See MIT STUDY, *supra* note 90, at 2–15.

293. POSNER, *supra* note 247, at 33.

294. See Felix S. Cohen, *Dialogue on Private Property*, 9 RUTGERS L. REV. 357, 374 (1954).

out, or assert claims to definite, unused spaces in the air in order to protect some contemplated future use of it. . . . If such a rule were conceivable, how will courts protect the various landowners in their varying claims of portions of the sky? How enforce a right of ejectment or restitution?²⁹⁵

The recognition of property rights in the deep subsurface presents similar enforcement challenges, as *Chance* and similar fluid migration decisions demonstrate.²⁹⁶ It is impractical to allow surface owners to declare portions of the subsurface off limits to migrating substances in order to preserve the option for some future, unspecified use. Due to the geophysical complexity of the subsurface even a few miles deep, it is difficult to prove the existence or absence of subsurface intrusions by migrating fluids. Of course, this difficulty becomes more pronounced with depth.

In fact, even if enforcement were otherwise possible, the boundaries of supposed subsurface parcels are impossible to locate—creating an enforcement nightmare. As Part II demonstrates, the earth's interior is subject to at least five different forms of motion. The crust and upper mantle float on a layer of largely molten rock, moving sideways in relation to the mantle below like ice blocks on a lake. The components of the middle and lower mantle themselves move horizontally and vertically; the molten outer core flows in a different direction; and the inner core rotates more quickly than the upper layers. Thus, the theory that the surface owner holds title to a definable, rock-like pillar of earth from the surface to the core is scientifically impossible. Rather, each component is in motion.²⁹⁷

295. *Hinman v. Pac. Air Transp.*, 84 F.2d 755, 758 (9th Cir. 1936).

296. See *supra* notes 260–268 and accompanying text.

297. Law and economics theory offers useful insights here. Richard Posner has suggested that a key feature of a private property system is that “[ownership] rights must be [freely] transferable.” POSNER, *supra* note 247, at 33. But transferability is illusory unless the scope of the rights being transferred can be defined in a meaningful fashion. As discussed in the text above, the boundaries of deep subsurface parcels are impossible to locate due to various forms of motion within the earth. Thus, Paul Rubin’s qualification to Posner’s view is directly relevant: “Everything must be owned for efficiency (at least up to the point where enforcement of title is more expensive than the value of ownership).” Paul H. Rubin, *Common Law and Statute Law*, 11 J. LEGAL STUD. 205, 208 (1982). Given the inherent problems in enforcing subsurface property rights—including ever-shifting boundaries—enforcement costs may well exceed the fair market value of a subsurface parcel. For example, it seems likely that the fair market value of a subsurface parcel located more than 1000 feet below the land surface is probably zero, absent special mineral value.

4. Environmental Concerns

In a broad sense, the deep subsurface may be viewed as a type of wilderness: a pristine, natural region largely unaffected by human conduct.²⁹⁸ The interior of the earth is a new frontier, almost entirely unexplored; humans have physically traveled less than two miles below the earth's surface. Thus, almost all of the interior remains in primeval condition, untouched by the human hand. If we view the earth's interior as a special type of wilderness, then arguably it should be safeguarded for future generations by restricting subsurface ownership.

An extensive body of federal, state, and local laws facilitates the preservation of environmentally sensitive lands.²⁹⁹ Consistent with utilitarian theory, the law protects these lands primarily because of the benefits they may potentially provide to humans.³⁰⁰ For instance, a species thought to be worthless to humans today may someday have value as technology progresses. This principle is demonstrated by the Pacific Yew tree—long denigrated by loggers as worthless for lumber—whose bark was found to contain a substance now used to treat certain forms of cancer.³⁰¹ A second, more muted theme underlying wilderness protection is moral duty: the concept that other species should enjoy a right to exist.³⁰² Survey data show that most Americans agree that moral duty requires the preservation of nonhuman species.³⁰³

298. This standard reflects the working definition of "wilderness" embodied in decisions concerning tracts of wild and undeveloped land that are not subject to the federal Wilderness Act, 16 U.S.C. §§ 1131–36 (2000). See John G. Sprankling, *The Antiwilderness Bias in American Property Law*, 63 U. CHI. L. REV. 519, 562 (1996). Although applicable only to certain federally owned lands, the definition in the Wilderness Act is also helpful by analogy: "an area of undeveloped . . . land retaining its primeval character and influence . . . which . . . generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable." 16 U.S.C. § 1131(c).

299. See generally FRANK P. GRAD, *TREATISE ON ENVIRONMENTAL LAW* (2006); LINDA A. MALONE, *ENVIRONMENTAL REGULATION OF LAND USE* (2006).

300. For example, the U.S. Congress adopted the Wilderness Act "to secure for the American people of present and future generations the benefits of an enduring resource of wilderness." 16 U.S.C. § 1131(a). In this context, wilderness is seen as a "resource" for human use. See generally Sprankling, *supra* note 298, at 521–33 (discussing early American attitudes toward wilderness).

301. See Sharon Begley & Patricia King, *The Lowly Yew Yields Riches*, NEWSWEEK, Nov. 11, 1991, at 67.

302. The foremost exponent of this view was Aldo Leopold, who advocated a "land ethic" that would respect the rights of all species to exist in harmony with the environment. See ALDO LEOPOLD, *A SAND COUNTY ALMANAC* 201–26 (Oxford 1949); see also James P. Karp, *Aldo Leopold's Land Ethic: Is an Ecological Conscience Evolving in Land Development Law?*, 19 ENVTL. L. 737 (1989).

303. See THE ROPER ORG., *NATURAL RESOURCE CONSERVATION: WHERE ENVIRONMENTALISM IS HEADED IN THE 1990S*, at 62 (1992).

Similarly, international law increasingly recognizes the importance of protecting wilderness lands. For example, the landmark Stockholm Declaration of the United Nations on the Human Environment³⁰⁴ provided that “[t]he natural resources of the earth including the air, water, land, flora, and fauna . . . must be safeguarded for the benefit of present and future generations through careful planning or management.”³⁰⁵ In this spirit, a number of international conventions provide that certain regions—such as the moon and the deep sea floor—are part of the “common heritage” of all humans and, accordingly, are not subject to private property rights.³⁰⁶

Scientific research demonstrates that life forms do exist in the deep crust. For example, bacteria have been discovered almost two miles deep in Virginia³⁰⁷ and over three miles deep in Sweden.³⁰⁸ Concluding that “[t]here are strong indications that microbial life is widespread at depth in the crust of the Earth,” one scientist suggested that life may be found at levels more than six miles deep.³⁰⁹ Because humans have never penetrated below the crust, it is impossible to know whether life exists there, although the extreme heat makes this unlikely.³¹⁰ While the potential value of subsurface life to humans is unknown, one major pharmaceutical company has committed to examine 3200 types of subsurface bacteria in the hope of developing new products.³¹¹

Federal law already regulates private access to the subsurface, in part to protect environmental values. The statutes restricting injection wells and surface coal mining, for example, reflect the need to limit private property

304. June 16, 1972, 11 I.L.M. 1416.

305. *Id.* at 1418.

306. See, e.g., Agreement Governing the Activities of States on the Moon and Other Celestial Bodies art. 11(3), Jul. 11, 1984, 1363 U.N.T.S. 22, 25; United Nations Convention on the Law of the Sea, arts. 1, 136, Dec. 10, 1982, 1833 U.N.T.S. 3, 399, 446. It should be noted, however, that the United States is not a party to either of these conventions. But the United States has ratified the Outer Space Treaty; Article II of that treaty provides that outer space, including the moon and other celestial bodies, is not subject to national appropriation by any claim of sovereignty, which effectively bars the establishment of private property rights in outer space. 1967 Treaty, *supra* note 270.

307. David R. Boone et al., *Bacillus Infernus Sp. Nov., an Fe(III)- and Mn(IV)-Reducing Anaerobe From the Deep Terrestrial Surface*, 45 INT'L J. SYSTEMATIC BACTERIOLOGY 441 (1995) (discussing bacteria located in core samples taken 1.7 miles below surface).

308. See Ulrich Szewzyg et al., *Thermophilic, Anaerobic Bacteria Isolated From a Deep Borehole in Granite in Sweden*, 91 PROC. NAT'L ACAD. SCI. 1810 (1994) (discussing bacteria discovered in water that entered a borehole at about three miles underground).

309. Thomas Gold, *The Deep, Hot Biosphere*, 89 PROC. NAT'L ACAD. SCI. 6045, 6045 (1992).

310. See *id.* at 6048.

311. James K. Fredrickson & Tullis C. Onstott, *Microbes Deep Inside the Earth*, SCI. AM., Oct. 1996, at 68, 73.

rights in order to avoid environmental damage.³¹² In the same manner, environmental concerns should be considered as a factor in determining the general extent of subsurface property rights.³¹³

5. New Technologies

Utilitarian theory teaches that overall societal welfare may require limitations on property rights. As one judge summarized: “Private property . . . is essential to our way of life But reducing too much to private property can be bad medicine.”³¹⁴ Too much private property, in short, may be as injurious as too little. As applied to real property, one problem in this regard is excessive fragmentation. Thus, Michael Heller observed that “[w]hen public policy encourages the formation of lots that are too small to use productively, owners may have a difficult time aggregating them to a more viable scale.”³¹⁵ He suggested that property law responds to this dilemma through “diverse doctrines that prevent and abolish excessive fragmentation and keep resources well-scaled for productive use.”³¹⁶ Heller’s insight applies directly to the millions of long, narrow subsurface parcels—somewhat like pieces of string—that logically arise from the center of the earth theory. This fragmentation has the potential to interfere with new technologies such as carbon sequestration, heat mining, and other valuable uses that would occupy large subsurface regions.

As noted above,³¹⁷ the landmark decision signaling the demise of the *ad coelum* doctrine is *United States v. Causby*,³¹⁸ in which the Supreme Court reasoned that the concept “had no place in the modern world” because it would subject any airline to repeated trespass suits.³¹⁹ The Court explained that “[t]o recognize such private claims to the airspace would clog these highways, [and] seriously interfere with their control and development in the public interest.”³²⁰ In *Causby*, the Court confronted the fragmentation problem in the context of airspace—recognizing the surface

312. See *supra* notes 210–213 and 225–234 and accompanying text.

313. Of course, the normal functioning of the earth’s interior is essential to the existence of all life. A disruption of the magnetic field created by the outer core, for example, would subject the earth’s surface to dangerous gamma rays and X-rays. See *supra* note 122 and accompanying text.

314. *White v. Samsung Elecs. Am., Inc.*, 989 F.2d 1512, 1513 (9th Cir. 1993) (Kozinski, J., dissenting).

315. Michael A. Heller, *The Boundaries of Private Property*, 108 YALE L.J. 1163, 1172 (1999).

316. *Id.* at 1165.

317. See *supra* text accompanying notes 146–147.

318. 328 U.S. 256 (1946).

319. *Id.* at 260.

320. *Id.* at 261.

owners' title to the columns of airspace above millions of parcels would give them virtual veto power over airplane travel, thus clogging the highways of the sky. The subsurface rights arising from the center of the earth theory may produce much the same problem.

President George W. Bush has emphasized that "technology offers great promise to significantly reduce [greenhouse gas] emissions—especially carbon capture, storage, and sequestration technologies."³²¹ Carbon sequestration is a technique for mitigating the impact of global climate change by removing carbon dioxide from the air and then storing it in deep subsurface layers, such as depleted oil and gas reservoirs, saline formations, coal seams, shales, and basalts.³²² In field tests, carbon dioxide has been successfully injected into wells ranging in depth from 1000 feet to over two miles.³²³ Although the first large-scale demonstration project will not begin until 2011,³²⁴ it is already clear that each facility will require a large subsurface parcel. For example, the U.S. Department of Energy estimated that the area of contamination "from an injection of one million tons of CO₂ per year in a deep saline formation for 20 years could be spread over a horizontal area of 15 square miles or more."³²⁵ Another study, by the Intergovernmental Panel on Climate Change, suggested that injected carbon dioxide might disperse into an area of about thirty-eight square miles over thirty years.³²⁶

Heat mining, or "enhanced geothermal systems," is a novel method of producing energy from noncarbon sources, which could be beneficial in reducing our dependence on fossil fuels.³²⁷ A recent study by the Massachusetts Institute of Technology (MIT) estimated that over time, this technology could produce over one hundred billion watts of electrical power,³²⁸ enough

321. U.S. Dep't of Energy, Fossil Energy: DOE's Carbon Sequestration Research Program, <http://www.fossil.energy.gov/programs/sequestration/index.html> (last visited Feb. 9, 2008) (alteration in original) (quoting President George W. Bush); see also Stephanie M. Haggerty, Note, *Legal Requirements for Widespread Implementation of CO₂ Sequestration in Depleted Oil Reservoirs*, 21 PACE ENVTL. L. REV. 197 (2003) (discussing carbon sequestration generally).

322. U.S. DEP'T OF ENERGY, CARBON SEQUESTRATION TECHNOLOGY ROADMAP AND PROGRAM PLAN 20 (2007).

323. *Id.* at 39.

324. *Id.* at 11.

325. *Id.* at 27.

326. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE WORKING GROUP III, SPECIAL REPORT ON CARBON DIOXIDE AND CAPTURE 256 (2005) (predicting dispersal of carbon dioxide over one hundred square kilometers).

327. See MIT STUDY, *supra* note 90.

328. *Id.* at 1–3 ("[Enhanced Geothermal Systems] could provide 100 [Gigawatt-electric] or more of cost-competitive generating capacity in the next 50 years.").

to meet 10 percent of America's needs by 2050.³²⁹ Heat mining involves the creation of an artificial geothermal energy plant: Water is injected down a well between one and six miles deep,³³⁰ reaching rock with a natural heat level of 150° to 250°C; this heat creates steam, which is captured by another well and then transported to the surface to turn turbines that generate electricity.³³¹ A heat mining facility would include a number of wells, covering a subsurface area of over four square miles or more.³³² The MIT study concluded that "it may be possible to site [such facilities] within populated and industrial districts, a clear advantage over fossil or nuclear plants."³³³

Just as the new technology of the airplane ended the *ad coelum* era, new technologies for large-scale use of the deep subsurface—such as carbon sequestration and heat mining—may herald the end of the center of the earth approach. Under this theory, the subsurface is broken up into columns of rock and soil owned by the surface owners. This logically creates a multitude of extremely thin columns. Consider, for example, a residential subdivision consisting of 500 homes, each one located on a lot 75 feet wide and 150 feet long. In order to use the entire subsurface, an enterprise would need to acquire title to 500 different columns. If any single owner refused to sell his subsurface rights—or demanded an exorbitant price—the entire project would be endangered.³³⁴ Such a patchwork of extremely small, individually owned subsurface parcels would make it difficult to develop large-scale subsurface projects that serve the public interest.³³⁵ The problem

329. Mark Clayton, *Mining Heat From the Earth? New Technology Shows Promise*, CHRISTIAN SCI. MONITOR, Feb. 7, 2007, at 1.

330. *Id.*

331. MIT STUDY, *supra* note 90.

332. *Id.* at 8–7 (noting that "well fields can cover a considerable area, typically 5 to 10 km² or more").

333. *Id.* at 8–16.

334. The holdout problem is well recognized by the scholarly literature in the context of surface rights. See, e.g., Marc B. Mihaly, *Living in the Past: The Kelo Court and Public-Private Economic Redevelopment*, 34 ECOLOGY L.Q. 1, 26 (2007) ("[A] major obstacle to economic revitalization of urban cores is 'over-subdivision,' where old land use patterns leave an artifact of multiple small lots under different ownerships."). If a private developer tried to purchase multiple small parcels in order to create a large project, inevitably some owners would demand higher prices—well above fair market value—thus making the project financially unfeasible. *Id.*; see also Thomas W. Merrill, *The Economics of Public Use*, 72 CORNELL L. REV. 61, 74–75 (1986) (discussing the impact of holdouts).

335. Historically, a city or county confronted with one or more holdouts who refused to sell their properties for a socially valuable, but privately owned, project could acquire the land through eminent domain and resell the properties to the private developer. But after the Supreme Court's decision in *Kelo v. City of New London*, 545 U.S. 469 (2005), the scope of a local government's eminent domain power in such a situation is unclear. See, e.g., Daniel H. Cole, *Why Kelo Is Not Good News for Local Planners and Developers*, 22 GA. ST. U. L. REV. 803 (2006). Although Justice Kennedy voted to uphold the city's power to take in that case—thus becoming the fifth vote

would be less pronounced, of course, in rural areas with larger parcel sizes. Even here, however, it may be difficult to acquire the subsurface rights to thirty-eight square miles of land, the parcel size potentially needed for a use such as carbon sequestration.

B. Abolishing Ownership Below the Crust

American law has never determined whether a surface owner holds property rights in the zone from the mantle to the center of the earth, as demonstrated in Part III. Humans have never penetrated below the crust; no case holding or statute resolves the question; and the center of the earth theory of subsurface rights is mere hyperbole. As one modern English jurist characterized the existing case law: “In none of these cases is there an authoritative pronouncement that ‘land’ means the whole of the space from the centre of the earth to the heavens: so sweeping, unscientific and unpractical a doctrine is unlikely to appeal to the common law mind.”³³⁶ Thus, in determining whether ownership should extend below the crust, judges and legislators will confront an open issue.

The policy analysis above³³⁷ indicates that property rights should not extend below the crust. Most surface owners do not expect that their title reaches past the crust. Modern scientific research, unknown in Blackstone’s era, teaches that human access to this region is virtually impossible. The area is both unpossessed and incapable of possession, much like the surface of a distant planet: hotter than Venus, and just as deadly to humans. Thus, any attempt to enforce property rights in this area would be illusory. Environmental protection of the deep subsurface is best realized by barring private ownership at this time. Finally, if and when human use of the region becomes technologically possible, presumably large areas of access will be required for productive use, unfettered by a multitude of thin columns.

Assuming that the mantle, outer core, and inner core are not owned by surface owners, then who owns these regions? The best approach may be to view this area as public land owned by the federal government, much like a

needed for a majority—his concurrence stressed the fact that the identity of those who would benefit from the taking, the future developers, was unknown. See *Kelo*, 545 U.S. at 493 (Kennedy, J., concurring) This implies that he might not find the requisite “public use” if the project involved transferring land to a single new private owner whose identity is known in advance, which would probably be the case with a heat mining or carbon sequestration project.

336. Comm’r for Rys. v. Valuer-General, [1974] A.C. 328, 351–52 (Wilberforce, J.).

337. See *supra* Part IV.A.

national forest or a wildlife preserve.³³⁸ Almost by definition, any unowned land within a nation's territory is subject to governmental control. Moreover, this result is supported by empirical data from the June 2007 homeowner survey, as shown in the Appendix.³³⁹ When asked the question—"Who owns the land underneath your property?"—59 percent of the respondents said that it belonged to a governmental entity, while 20 percent thought that it belonged to "no one."³⁴⁰ Thus, vesting title in a governmental entity is broadly consistent with public expectations.

Federal and state governments already play a significant role in licensing access to the subsurface areas, as discussed in Part III. For instance, in some states, the surface owner may not remove groundwater without a permit; and the unitization of oil and gas production in certain jurisdictions inherently restricts private drilling. At the national level, a surface owner may not remove coal merely ten feet below ground level without a federal permit; similarly, a surface owner cannot install an injection well even 500 feet deep without a permit from the federal government or a federally approved state regulatory agency. Expanding the scope of this authority so as to require a federal permit for any type of access below the crust—usually more than twenty miles beneath the surface—would fit comfortably into this existing regulatory framework.³⁴¹

C. Models for Ownership Within the Crust

The surface owner should certainly hold property rights to a portion of the subsurface. At a minimum, efficient use of the land surface often requires

338. Alternatively, these regions could be designated as areas where no nation holds sovereignty, and thus subject to international regulation. Perhaps they could be classified as part of the "common heritage" of all humans, much like the moon and the high seas. See generally KEMAL BASLAR, *THE CONCEPT OF THE COMMON HERITAGE OF MANKIND IN INTERNATIONAL LAW* (1998).

339. See *infra* app.

340. See *infra* app.

341. But would such action constitute a taking of private property under the Fifth Amendment for which just compensation is required? Probably not. The closest case is *Loretto v. Teleprompter Manhattan CATV Corp.*, 458 U.S. 419 (1982), in which the Court held that any permanent physical occupation by the government was a compensatory taking. *Id.* at 426. But, in this context, it is apparent that the Court was concerned with governmental action that would adversely affect rights on the land surface. Underpinning the decision was the Court's recognition that "property law has long protected an owner's expectation that he will be relatively undisturbed at least in the possession of his property." *Id.* at 436. As shown in the Appendix, survey data indicate that a majority of owners have no expectation that their property rights extend to the deep subsurface, see *infra* app.—so the *Loretto* rationale is inapplicable. Cf. *FPL Farming, Ltd. v. Tex. Natural Res. Conservation Comm'n*, No. 03-02-00477-CV, 2003 WL 247183, at *5–6 (Tex. App. Feb. 6, 2003) (rejecting a claim that the deprivation of subsurface rights constituted a taking under *Loretto*).

that an ordinary owner have legal access to the zone immediately below the surface, for foundations, roots, wells, and the like. For almost 500 years, our common law system has accepted the owner's title to this near-surface zone.

But how deeply into the crust should the surface owner's rights extend? The analysis below explores four alternative models of subsurface ownership: (1) ownership within the entire crust; (2) ownership based on first-in-time exploitative use; (3) ownership for reasonable and foreseeable uses; and (4) ownership to a specified depth, such as 1000 feet. Title to the subsurface below this point should be vested in the federal government.

1. Ownership of the Entire Crust

One approach is to extend the surface owner's rights downward to the crust-mantle boundary, an average of twenty-two to twenty-five miles deep.³⁴² The central virtue of this model is maximum deference to the potential expectations of surface owners. Because humans have never penetrated into the mantle, it seems unlikely that landowners would truly expect to hold title to this region—which the homeowner survey data confirm. Certainly, entities with existing operations in the deep crust, notably companies operating oil, gas, or injection wells may hold expectations that their property rights extend even more deeply; but it is possible to accommodate these specialized concerns in a narrower manner, as discussed below.³⁴³

A second virtue of this model, when compared with the next two alternatives, is a more clearly defined lower boundary for property rights: the point where the crust reaches the mantle. Although the depth of the continental crust varies somewhat, it is scientifically possible to determine this line, in an approximate sense, by measuring density.³⁴⁴ This certainty, in turn, promotes transferability and hence efficiency.

This model otherwise suffers from the same problems that infect the center of the earth approach. The deep crust is unpossessed and incapable of possession; the enforcement of subsurface property rights at that depth is impractical; environmental concerns are ignored; and new technologies are potentially stifled. Ultimately, the average surface owner has no legitimate interest in controlling the deep crust.

342. A variant on this approach would be to extend the surface owner's rights to the entire lithosphere, including the entire crust and the upper mantle. Under this approach, title would extend down through the entire North American tectonic plate to the layer of molten rock upon which it floats. See generally *supra* notes 96–98 and accompanying text.

343. See *infra* note 356 and accompanying text.

344. See *supra* notes 99–101 and accompanying text.

2. Ownership Based on First-in-Time Exploitative Use

Our de facto system for allocating deep subsurface property rights essentially vests title in the first person to use the subsurface for a productive purpose, regardless of where his surface rights are located.³⁴⁵ Thus, to a large extent, property rights in subsurface resources such as water, oil, gas, and waste disposal capacity have been assigned through a rule of capture: The first captor owns the resource, whether or not it is located under his land surface. Of course, this basic approach is increasingly modified by governmental regulation. However, shorn of regulatory limits, it offers another possible model for subsurface ownership. The logic of this model suggests that the surface owner holds no subsurface rights until and unless she undertakes some economically viable subsurface use. Before that point, she holds merely a potential, inchoate interest in the subsurface, just as one holding a hunting license does not yet own any wild game.

This model arguably satisfies concerns based on expectations. Presumably, specialized entities that are already involved in productive uses of the deep subsurface expect that the current approach will continue. Moreover, this approach is consistent with the homeowner survey in that it deprives the ordinary owner of property rights below the immediate land surface, which is what the respondents actually expect. But the sophisticated owner with an expectation of using his subsurface for a future project may lose the race to his neighbor who acts first and thereby captures the resource.³⁴⁶

However, this approach fails to satisfy the other concerns discussed above. First, while oil, gas, and injection wells do penetrate into the deep subsurface, it would be elevating form over substance to suggest that these isolated intrusions should be viewed as “possession” of the subsurface. Another problem is that under this approach the extent of property rights would be poorly defined. Due to the complexity of subsurface geology, it would be impossible to delineate the horizontal and vertical contours of each subsurface “parcel” that has been “captured” (such as by injecting liquid wastes).³⁴⁷ This presents the enforceability problems described above; it also impairs the marketability of these parcels and other adjacent

345. This is part of an approach to property rights that I have elsewhere called “exploitative utilitarianism.” John G. Sprankling, *An Environmental Critique of Adverse Possession*, 79 CORNELL L. REV. 816, 856 (1994).

346. See, e.g., *Sunoco Partners Mktg. & Terminals LP v. EPA*, No. 05-7472, 2006 U.S. Dist. LEXIS 2817 (E.D. Mich. Jan. 20, 2006) (denying an injunction to bar the expansion of the defendant’s injection of subsurface wastes, even though plaintiff planned a competing project).

347. In addition, the downward extent of ownership would vary from parcel to parcel—depending on the extent of exploitative use—producing both confusion and inefficiency.

subsurface lands by making them more difficult to transfer.³⁴⁸ Next, it is generally accepted that a capture rule facilitates the destruction of natural resources, because it provides no incentive to preserve those resources for future use; they must be either used immediately or lost forever.³⁴⁹ Thus, viewing the natural subsurface as a resource, this approach would encourage wasteful practices that might well cause irreparable damage. Finally, by vesting property rights in the first-in-time user, this model makes it more difficult to develop new, more technologically advanced subsurface uses.

3. Ownership Based on Reasonable and Foreseeable Use

A handful of thoughtful American decisions support extending the surface owner's rights downward to the underlying subsurface as necessary to protect existing uses that are both reasonable and foreseeable. For example, the Ohio Supreme Court reasoned in *Chance v. BP Petroleum, Inc.*³⁵⁰ that the surface owner could exclude invasions by others that "actually interfere with [the owner's] reasonable and foreseeable use of the subsurface."³⁵¹

This view is a variant on the first-in-time model discussed above: Unless the surface owner is already engaged in a reasonable and foreseeable use, a first-in-time stranger may capture the subsurface. Thus, it suffers from the same defects inherent in the first-in-time model, except in two areas. First, the reasonable and foreseeable use model arguably protects the legitimate expectations of the sophisticated surface owner, because it extends to only foreseeable uses, that is, those that a person would expect to be able to engage in. Thus, for example, this approach would respect existing investments in oil, gas, and waste injection wells. Second, this model may provide some protection for environmental values, because it gives the surface owner an incentive to engage in only reasonable uses, a standard that may impliedly consider the extent of environmental degradation.

4. Ownership to a Specified Depth

A final model is to restrict the surface owner's rights to the subsurface to a specific depth zone, such as 500 feet, 1000 feet, or one mile deep. This

348. See generally *supra* note 297.

349. See, e.g., Dale D. Goble, *Three Cases/Four Tales: Commons, Capture, the Public Trust, and Property in Land*, 35 ENVTL. L. 807, 814–17 (2005) (analyzing the effect of the capture rule on natural resources).

350. 670 N.E.2d 985 (Ohio 1996).

351. *Id.* at 992.

approach is premised on the idea that subsurface rights should exist only to the extent reasonably necessary to facilitate the owner's use of the surface. Just as the airspace cases suggest that the surface owner holds title only to the zone immediately above her land surface (usually up to 500 feet),³⁵² this model recognizes her title only to the zone immediately beneath the surface.

One of the few decisions implementing this approach is *Boehringer v. Montalto*,³⁵³ in which a New York court rejected the claim that a public sewer line 150 feet deep violated a deed covenant against encumbrances.³⁵⁴ After discussing the demise of the *ad coelum* approach to airspace, the court concluded:

It, therefore, appears that the old theory that the title of an owner of real property extends indefinitely upward and downward is no longer an accepted principle of law in its entirety. Title above the surface of the ground is now limited to the extent to which the owner of the soil may reasonably make use thereof.

By analogy, the title of an owner to the soil will not be extended to a depth below ground beyond which the owner may not reasonably make use thereof.

It is concluded that the depth at which the . . . sewer exists is beyond the point to which the owner can conceivably make use of the property³⁵⁵

Boehringer thus suggests that the zone of subsurface ownership should be less than 150 feet deep, at least as applied to residential property. While reasonable minds could certainly differ on the point, a deeper zone—perhaps 1000 feet downward—seems more appropriate as a general rule, by analogy to the airspace decisions.

However, many oil, gas, and hard rock mineral operations now function at levels far below 1000 feet. The simplistic zone model fails to protect vested rights in specific minerals and to encourage development of new

352. Federal law generally defines navigable airspace as the zone more than 500 feet above the land surface, with exceptions for flights over sparsely populated areas or over water. 14 C.F.R. § 119 (2007).

353. 254 N.Y.S. 276 (Spec. Term 1931); cf. *Thrasher v. City of Atlanta*, 173 S.E. 817, 826 (Ga. 1934) (suggesting, in the context of airspace rights, that “[p]erhaps the owner of the land may be considered as being in actual possession of the space immediately covering the trees, buildings, and structures affixed to the soil, so that the act of navigating a plane through this stratum could be condemned as a trespass”).

354. *Boehringer*, 254 N.Y.S. 276; see also *First Unitarian Soc’y v. Citizens Sav. & Trust Co.*, 142 N.W. 87 (Iowa 1913) (holding that a public sewer line six feet below the land surface did not breach the covenant against encumbrances); cf. *In re Application of Gillespie*, 17 N.Y.S.2d 560 (Gen. Term 1940) (awarding only nominal damages for the construction of a tunnel 500 feet below the land surface because it did not interfere with surface use or diminish property value).

355. *Boehringer*, 254 N.Y.S. at 278.

mineral resources. One partial solution is to modify this model by honoring all existing rights to extract specific valuable minerals, at least to the extent appropriate to ensure a reasonable return on prior investments.³⁵⁶

With this modification, the zone model comes closest to meeting the subsurface ownership criteria discussed above. First, it is consistent with the homeowner survey data, which indicate that the majority of owners expect only very shallow ownership: 76 percent believe their rights extend downward 100 feet or less. Second, the subsurface within the 1000 foot zone is readily susceptible of possession: It is relatively immovable; temperature, pressure, and other conditions there readily support human life; and virtually all past human activity in the subsurface is within this region. Third, in general, this zone is sufficiently close to the surface both to delineate parcel boundaries and to enforce property rights, at least in comparison to much deeper regions. Fourth, by minimizing private subsurface ownership, this approach is the most protective of environmental values. Finally, this model best facilitates the development of new subsurface technologies by avoiding the inefficiency inherent in trying to assemble many small parcels. The federal government can regulate access to large subsurface areas below 1000 feet for uses such as carbon sequestration, heat mining, and other future technologies.

CONCLUSION

Oliver Wendell Holmes once remarked that “[i]t is revolting to have no better reason for a rule of law than that so it was laid down in the time of Henry IV.”³⁵⁷ He accordingly bemoaned the continued existence of any “rule [that] simply persists from blind imitation of the past.”³⁵⁸

Holmes’s comment neatly captures the absurdity of the center of the earth approach to subsurface ownership. Blackstone’s theory was not forged in the furnace of logic, but rather proclaimed as natural law that was immune

356. Crafting such a modification will require care. Because “mineral” is broadly defined in many states, potentially including almost everything under the surface, an exclusion for “all” mineral rights would vitiate the zone model. Compare *Sellars v. Ohio Valley Trust Co.*, 248 S.W.2d 897, 899 (Ky. 1952) (defining “minerals” to include “all organic and inorganic substances that can be taken from the earth”), with *W.S. Newell, Inc. v. Randall*, 373 So. 2d 1068, 1070 (Ala. 1979) (noting that “mineral” connotes “a substance rare and exceptional in character possessing special value”). See generally George E. Reeves, *The Meaning of the Word “Minerals,”* 54 N.D. L. REV. 419, 423 (1978) (observing that the term “has no definite and certain meaning”). At the same time, existing investments in oil, gas, and hard rock mining operations should be respected.

357. Oliver W. Holmes, *The Path of the Law*, 10 HARV. L. REV. 457, 469 (1897).

358. *Id.*

from rational debate. Center of the earth rhetoric lingers today in case law and legal scholarship largely due to uncritical acceptance of Blackstone's endorsement. As Holmes would have said, it is blind imitation of the past.

The idea that the surface owner held title up to the heavens could be dismissed as harmless hyperbole until it threatened the development of the airplane. Given our modern scientific knowledge and new advances in subsurface technology, we must now confront the equally foolish notion that the surface owner holds title to the center of the earth—including a slice of the planet's molten core. Lacking support in either law or logic, the center of the earth approach is merely a curious relic from a bygone age.

Demolition is easier than construction. If we accept the premise that the center of the earth orthodoxy must be abandoned, then the difficult question is what should replace it. The analysis above strongly suggests that private property rights should not extend below the earth's crust. While many models for delimiting rights within the crust might be considered, one promising model would recognize the surface owner's title to the subsurface only for a specific depth, such as 1000 feet. Of course, reasonable minds can fairly differ as to the appropriate extent of property rights within the crust. The goal of this Article is to ignite that debate, not to extinguish it.

APPENDIX: RESULTS OF JUNE 2007 HOMEOWNER SURVEY³⁵⁹

1. *How far below the surface does your property ownership extend?*
If you're not sure, please give us your best estimate.

10 feet: 49%
100 feet: 27%
1000 feet: 5%
1 mile: 3%
10 miles: 1%
100 miles: 0
1000 miles: 1%
To the center of the earth: 14%

2. *Who owns the area underneath your property?*
If you're not sure, please give us your best estimate.

The federal government: 10%
The state: 16%
The county: 16%
The city: 17%
A private person or company: 21%
No one: 20%

359. This survey was conducted by having one hundred homeowners in Davis, California fill out survey cards in June 2007. Each card contained the two multiple-choice questions set forth above, one on each side of the card. Each respondent was asked to answer Question 1 before seeing Question 2, in order to minimize any bias that might result from the text of Question 2. It would be inappropriate to put too much reliance on the survey results, though, because the sample size was small and the methodology informal. A more rigorous empirical study of owners' expectations would be helpful.