Literature references and short presentation topics, EPMD-course 2023

(Since initial publication, the file has been updated with a few text corrections and more specific titles and references for topics 9a and 9b)

The backbone of the course material will be the electronic presentations available as ppt- and pdf-files, prepared for the oral presentations. Further insights can be found in original research articles and review papers. The articles listed under "**Short presentation topics with references**" (below) will be a good starting point. The general background references in the form of textbooks and review paper collections may be appropriate supplements. Several thematic issues of Elements have also focussed on the topics of this course. There is no specific "syllabus" but the most central course themes are summarised in:

Trønnes 2010, Structure, mineralogy and dynamics of the lowermost mantle. Mineral. Petrol. 99, 243-261.

Trønnes et al. 2019, Core formation, mantle differentiation and core-mantle interaction within Earth and the terrestrial planets. Tectonophys. 760, 165-198.

The first of these two articles, which might be the easiest to read, is now a bit outdated on some aspects of the lowermost mantle. The second article is more wide-ranging in terms of terrestrial planetary structure and composition and focuses considerably on the central theme of chemical exchange between an early magma ocean and the protocore and later exchange between the basal magma ocean and the evolving core.

Other articles and a book, which may give rather illustrative and updated views on the earliest Solar system and Earth evolution, might be:

Burkhardt et al. Terrestrial planet formation from lost inner solar system material. Sci. Adv. 7, eabj7601. (possibly a bit difficult to read?)

Halliday & Canup 2021. The accretion of planet Earth. Nat. Rev. Earth Env. 4, 19-35.

Borg & Carlson 2023. The Evolving Chronology of Moon Formation. Ann. Rev. Earth Planet, Sci. 51, 25-52 (posted as in advance / in press).

Harrison, T.M. 2020. Hadean Earth. Springer. (Open access, it seems)

All of these references are available on the course site, some of them in the "Articles, reviews" folder.

General background references

Treatise on Geophysics, second edition, 2015:

The updated and revised second edition of Treatise on Geophysics (Elsevier) was published in 2015 and the University of Oslo has acquired the entire electronic version of this. I have saved many of the chapters in the course folder. Some of your home institutions might possibly not have this 11-volume, 191-chapter reference collection. I have published a few chapters which I find most interesting and relevant for the course. **Because this review collection is recently updated, I think it might be a good course reference**.

Treatise on Geochemistry, first edition, 2003:

We do not have electronic access to the 2014-edition. I have PDF-files of the individual chapters in:

Vol. 1. Meteorites, Comets, and Planets

Vol. 2. The Mantle and Core

Vol. 3. The Crust

There are also a few other subfolders with various articles at the course site. I assume that you have access to the mainstream literature, but if some of you think that I might be able to send you something that you cannot access, please ask about it.

Textbooks

Davies G. 2001, **Dynamic Earth. Plates, Plumes and Mantle Convection**. Cambridge Univ. Press.

Harrison, T.M. 2020, **Hadean Earth**. Springer. (Open access, it seems)

Hazan, R.M. and Downs (eds.) 2000, **Ultrahigh-Pressure Mineralogy: Physics and Chemistry of the Earth's Deep Interior**. Rev. Mineral. Geochem. 41, Mineral. Soc. America.

Hemley, R.J. (ed.) 1998, **Ultrahigh-Pressure Mineralogy: Physics and Chemistry of the Earth's Deep Interior**. Rev. Mineral. 37, Mineral. Soc. America.

Hirose K et al., (eds.) 2007, **Post-Perovskite. The Last Mantle Phase Transition**. Geophys. Monogr. 174. Am. Geophys. Union.

Jackson, I. (ed.) 1998, **The Earth's Mantle. Composition, Structure and Evolution.** Cambridge Univ. Press.

Jolliff et al. (eds.) 2008, **New Views of the Moon.** Rev. Mineral. Geochem. 60, Mineral. Soc. America. and Geochem. Soc.

McBride, N. and Gilmour, I. (eds.) 2004, **An Introduction to the Solar System**. Cambridge Univ. Press.

MacPherson et al. (eds.) 2008, **Oxygen in the Solar System.** Rev. Mineral. Geochem. 68, Mineral. Soc. America. and Geochem. Soc.

Papike, J.J (ed.) 1998, **Planetary Materials**. Rev. Mineral. 36, Mineral. Soc. America.

van der Hilst, R.D., Bass, J., Matas, J., Trampert, J. (eds.) 2005, **Earth's Deep Mantle: Structure, Composition, and Evolution**. American Geophys. Union. Monograph 160.

Wentzcovitch and Stixrude (eds.) 2009, **Theoretical and computational methods in Mineral Physics: Geophysical Applications.** Rev. Mineral. Geochem. 71, Mineral. Soc. America. and Geochem. Soc.

Short presentation topics with references

I grouped the topics into thirteen broader themes and used headings in **red colour** for these themes. You might possibly find even more updated and interesting references for some of the topics. Because a 10 minute presentation is very short, I would encourage you to avoid attempts to give comprehensive reviews of the topics. Try to **introduce the topics very briefly** and identify the **main conclusions** and their **possible implications**. In the subsequent short discussions, and hopefully in the associated lecture presentations, I/we will try to put the presented topics into a broader context. I have marked a few of the references I consider most essential **in purple colour** – this is only a guide for you.

Most of the listed references are in the appropriate folders at:

https://www.nhm.uio.no/english/about/organization/research-collections/people/rtronnes/1/epmd/

If you cannot find a specific reference there or in the library system of your institution, you can ask me for it (but please try e.g. Research gate or other repositories first). Many of the volumes and chapters of e.g. Reviews of Mineralogy and Geochemistry are openly accessible now.

Some unconventional journal abbreviations used in the PDF-article names and on my lecture slides:
EPSL: Earth Planet. Sci. Lett.; GP: Geochem. Persp.; GPL: Geochem. Persp. Lett.; GCA, Geochim.Cosmochim. Acta; GRL: Geophys. Res. Lett.; JGR: J. Geophys. Res.; GGG: Geochem. Geophys. Geosyst. AGU-A: AGU Advances; AGU-Mgr: AGU Monograph; MPS: Meteoritic Planet. Sci.; PEPI: Phys.Earth Planet.Int.; PNAS: Proc. Nat. Acad. Sci. (USA). Nat: Nature; Sci: Science; NG or Ngeo: Nat. Geosci; NAstr: Nat. Astronomy; NC: Nat. Comm., NREE: Nat. Rev. Earth Env.; SA; Sci. Adv.; AnnRev: Annu. Rev. (mostly in Earth Planet. Sci); ChemG: Chem. Geol.; mp: Mineral. Petrol., SSR: Space Sci. Rev.; Tect: Tectonophys.; TGeoph: Treatise Geophys; Tgeoch.: Treatise Geochem. There might also be a few more that I neglected here.

Unfortunately, my Vortex-based website system modifies file names such that capitalised letters are changed to lower-case, and subscripts and superscripts are converted to ordinary text.

Address to the Google-spreadsheet for signing up:

https://docs.google.com/spreadsheets/d/1hhGlr4GLGEVH3fHRn1R29PXCKvUP-THgKDdUBolpuTk/edit?usp=sharing

Please remember to check that your favoured topic has not been selected already.

1. Solar system accretion: chronology and composition

1a. Chronology of the early Solar system

Articles in Special issue on: "Cosmochemistry", Elements 7, 11-40 (February 2011).
Amelin Y, Ireland TR, 2013: Dating the oldest rocks ann minerals in the Solar system. Elements 9, 39-44.
Connelly, JN, Bizzarro M, Krot AN, Nordlund Å, Wielandt D, Ivanova MA, 2012. The absolute chronology and thermal processing of solids in the solar protoplanetary disk. Sci. 338, 651–655.
Schiller M, Connelly JN, Glad AC, Mikouchi T, Bizzarro M, 2015 Early accretion of protoplanets inferred from a reduced inner solar system ^{26}Al inventory. Earth Planet. Sci. Lett. 420, 45-54.

1b. Accretion disc provenance

Warren 2011. Stable-isotopic anomalies and the accretionary assemblage of the Earth and Mars: a subordinate role for carbonaceous chondrites. Earth Planet. Sci. Lett. 311, 93–100.
Kruijer et al. 2017. Age of Jupiter inferred from the distinct genetics and formation times of meteorites. PNAS 114, 6715-6716.
Brasser & Mojzsis 2020. The partitioning of the inner and outer Solar System by a structured protoplanetary disk. Nat. Astron. 4, 492-499.
Bermingham et al. 2020. The NC-CC isotope dichotomy: implications for the chemical and isotopic evolution of the early Solar System. Space Sci. Rev. 216, 133.
Krujier et al. 2019. The great isotopic dichotomy of the early Solar System. Nat. Astron. 4, 32-40.
Burkhardt et al. 2021. Terrestrial planet formation from lost inner solar system material. Sci. Adv. 7, eabj7601.

1c. Do the Mg/Si and Sm/Nd ratios differ between the Sun, chondrites and the bulk silicate Earth?

Caro G (2011) Early Silicate Earth Differentiation. Annu. Rev. Earth Planet. Sci. 39, 31-58.
Caro G, Bourdon B (2010) Non-chondritic Sm/Nd ratio in the terrestrial planets: consequences for the geochemical evolution of the mantle-crust system. Geochim. Cosmochim. Acta 74, 3333–49
Dauphas N, Poitrasson F, Burkhardt C, Kobayashi H, Kurosawa K (2015) Planetary and meteoritic Mg/Si and δ^{30}Si variations inherited from solar nebula chemistry. Earth Planet. Sci. Lett. 427, 236–248.
Frossard et al. 2022. Earth's composition was modified by collisional erosion. Science 377, 1529-1532.
Johnston et al. 2022. Nd isotope variation between the Earth-Moon system and enstatite chondrites Nature 611, 501-506.

1d. Geochemical aspects of accretion

Halliday & Canup, 2021. The accretion of planet Earth. Nat. Rev. Earth Env. 4, 19-35.
Dauphas & Pourmand 2011, Hf-W-Th evidence for rapid growth of Mars and its status as a planetary embryo. Nature 473, 489-492.
Wood 2008, Accretion and core formation: constraints from metal–silicate partitioning. Phil. Trans. R. Soc. A, 366, 4339-4355.
Wood 2011, The formation and differentiation of the Earth. Physics Today 64(12), 40-45.

1e. Late accretion, the "late veneer"

Carlson, 2017. Earth's building blocks. Nature 541, 468-470.
Dauphas, 2017. The isotopic nature of the Earth's accreting material through time. Nature 541, 521-524.
Fisher-Godde & Kleine, 2017. Ruthenium isotopic evidence for an inner Solar System origin of the late veneer. Nature 541, 525-527.
Budde et al. 2019. Molybdenum isotopic evidence for the late accretion of outer Solar System material to Earth. Nat. Astron. 3, 736-741.
Zhu et al. 2021. Common feedstocks of late accretion for the terrestrial planets. Nat. Astron. 5, 1286-1296.

1f. Volatile accretion

Broadley et al. 2022. Origin of life-forming volatile elements in the inner Solar System. Nature 611, 245-255.
Shi et al. 2022. Nitrogen isotope evidence for Earth's heterogeneous accretion of volatiles Nat. Comm. 13, 4769.
Martins et al. 2023. Nucleosynthetic isotope anomalies of zinc in meteorites constrain the origin of Earth's volatiles. Science 379, 369-372.
Nie et al. 2023. Meteorites have inherited nucleosynthetic anomalies of potassium-40 produced in supernovae. Science 379, 372-376.

2. Solar system accretion: physical models, Earth-Theia-Moon relations, magma oceans

2a. Accretion disk models

Canup 2008, Accretion of the Earth. Phil. Trans. R. Soc. A, 366, 4061-4075.
Chambers (2004) Planetary accretion in the inner Solar System EPSL 223, 241-252.
Walsh KJ, Morbidelli A, Raymond SN, O'Brien DP, Mandell AM (2011) A low mass for Mars from Jupiter's early gas-driven migration. Nature 475, 206-209.

2b. Pebble accretion

Witze 2018. Earth may have been formed by a bunch of tiny space pebbles. The Atlantic. www.theatlantic.com/science/archive/2018/04/planets-are-built-from-pebbles/558854/
Johansen & Lambrechts 2017. Forming planets via pebble accretion. Ann. Rev. Earth Plan. Sci. 45, 359-387.
Ormel (2017. The emerging paradigm of pebble accretion. In: Pessah,& Gressel (eds.), Formation, Evolution, and Dynamics of Young Solar Systems, Astrophysics and Space Science Library 445, 10.1007/978-3-319-60609-5_7.
Chambers 2016. Pebble accretion and the diversity of planetary systems. Astrophys. L. 825, 53.
Alibert 2018. The formation of Jupiter by hybrid pebble-planetesimal accretion. Nat. Astron. 2, 873-877.

2c. Moon formation: the proto-lunar disk (the synestia)

Lock & Stewart (2017). The structure of terrestrial bodies: Impact heating, co-rotation limits and synestias. JGR 122, 950–982.
Lock et al. (2018) The origin of the Moon within a terrestrial synestia. JGR 123, 910-951.
Stewart et al. (2019) The shock physics of giant impacts: key requirements for the equations of state. AIP Proc. 10.1063/12.0000946.

2d. Earth-Theia-Moon composition - devolatilisation

Wang & Jacobsen (2016) Potassium isotopic evidence for a high-energy giant impact origin of the Moon. Nature 538, 487-490.
Wang et al. (2019) An extremely heavy chlorine reservoir in the Moon: Insights from the apatite in lunar meteorites. Sci. Rep. 9, 5727.
Cano et al. (2020) Distinct oxygen isotope compositions of the Earth and Moon. Nat. Geosci. 13, 270-274.

2e. Lunar differentiation: crystallisation of the magma ocean

Several articles in "Origin of the Moon: challenges and prospects" Phil. Trans. Roy. Soc. A., 372, Sept. 2014
Shearer et al. (2009) Thermal and magmatic evolution of the Moon. Rev. Mineral. Geochem. 60, 365-518.
Trønnes 2019, Core formation, mantle differentiation and core-mantle interaction within Earth and the terrestrial planets. Tectonophys. 760, 165-198. (short review: section 3.6)

2f. The young Moon

Borg & Carlson 2023. The evolving chronology of Moon formation. Ann. Rev. Earth Planet. Sci. 51, 25-52 (posted as in advance / in press).

2g. Lunar crustal dichotomy

Loper & Wernes, 2002. On lunar asymmetries. 1. Tilted convection and crustal asymmetry. JGR 107, E6, 5046.
Werner & Loper, 2002. On lunar asymmetries. 2. Origin and distribution of mare basalts and mascons. JGR 107, E6, 5045.
Ohtake et al. 2012. Asymmetric crustal growth on the Moon indicated by primitive farside highland materials. Nat. Geosci. 5, 384-388.
Zhu et al. 2019. Are the Moon's nearside-farside asymmetries the result of a giant impact? JGR 124, 2117–2140.
Elardo et al. 2020. Early crust building enhanced on the Moon's nearside by mantle melting-point depression. Nat. Geosci. 13, 339-343.

2h. The role of magma oceans in early planetary differentiation

Caro et al. 2005. Trace-element fractionation in Hadean mantle generated by melt segregation from a magma ocean. Nature 436, 246–49
Labrosse et al. 2007. A crystallizing dense magma ocean at the base of the Earth's mantle. Nature 450, 866–869
Stixrude 2009. Thermodynamics of silicate liquids in the deep Earth. Earth Planet Sci Lett 278, 226–232
Elkins-Tanton, 2012. Magma oceans in the inner Solar System. Annu Rev Earth Planet Sci 40, 113-1139

3. Core segregation, composition and properties

3a. Redox conditions and segregation of the Earth's core

Wade J, Wood BJ (2005) Core formation and the oxidation state of the Earth. Earth Planet Sci. Lett. 236, 78-95.
Wood 2008, Accretion and core formation: constraints from metal–silicate partitioning. Phil. Trans. R. Soc. A, 366, 4339-4355.
Wood BJ, Walter MJ, Wade 2006, Accretion of the Earth and segregation of its core. Nature 441, 825-833.

3b. Constraints on the composition of Earth's core

Hirose et al., 2013, Composition and State of the Core. Ann. Rev. Earth Planet. Sci. 41, 657-691.
Badro et al. 2014. A seismologically consistent compositional model of Earth's core. Proc Natl Acad Sci USA 111, 7542–7545.
Badro et al. 2015. Core formation and core composition from coupled geochemical and geophysical constraints. Proc Natl Acad Sci USA 112, 12310-12314.
Umemoto & Hirose 2020. Chemical compositions of the outer core examined by first principles calculations. EPSL 531, 116009.
Li et al. 2022. The effect of water on the outer core transport properties. Phys. Earth Planet. Int. 329-330, 105907.

3c. A stagnant E'-layer of the outermost core

Brodholt & Badro 2017. Composition of the low seismic velocity E′ layer at the top of Earth's core. Geophys. Res. Lett. 44, 8303–8310.
Hernlund & McNamara 2015. The core-mantle boundary region. In: Treatise on Geophys. 7.11. pp. 461–519.
Irving et al. 2018. Seismically determined elastic parameters for Earth's outer core. Sci. Adv. 4, eaar2538.
Kaneshima 2018. Array analyses of SmKS waves and the stratification of Earth's outermost core. Phys. Earth Planet. Inter. 276, 234–246.
Trønnes 2019. Core formation, mantle differentiation and core-mantle interaction within Earth and the terrestrial planets.Tectonophys 760, 165-198.

3d. Thermal conductivity and heat sources in the core

Dobson 2016. Earth's core problem. Nature 534, 45
Pozzo et al. 2012. Thermal and electrical conductivity of iron at Earth's core conditions. Nature 485, 355–358.
Hernlund & McNamara, 2015. The core-mantle boundary region. In: Treatise on Geophys. 7.11. pp. 461–519.
Konopkova et al. 2016. Direct measurement of thermal conductivity in solid iron at planetary core conditions. Nature 534, 99-101.
Ohta et al. 2016. Experimental determination of the electrical resistivity of iron at Earth's core conditions. Nature 534, 95-98.
Wohlers & Wood, 2015. A Mercury-like component of early Earth yields uranium in the core and high mantle ^{142}Nd. Nature 520, 337-340.

3e. Sulphur incorporation and sulphide-silicate partitioning of key elements at variable oxygen fugacity

McCubbin et al. 2012. Is Mercury a volatile-rich planet? Geophys. Res. Lett. 39, doi:10.1029/2012GL051711.
Kiseeva & Wood 2013. A simple model for chalcophile element partitioning between sulphide and silicate liquids with geochemical applications. Earth Planet. Sci. Lett. 383, 68-81.
Kiseeva & Wood, 2015. The effects of composition and temperature on chalcophile and lithophile element partitioning into magmatic sulphides. Earth Planet. Sci. Lett. 424, 280-294.
Wohlers & Wood, 2015. A Mercury-like component of early Earth yields uranium in the core and high mantle ^{142}Nd. Nature 520, 337-340.
Wood & Kiseeva, 2015. Trace element partitioning into sulfide: How lithophile elements become chalcophile and vice versa. Am. Mineral.
Rubie et al. 2016. Highly siderophile elements were stripped from Earth's mantle by iron sulfide segregation. Science 353, 1141-1143.

3f. Composition and structure of the terrestrial planetary cores

Stewart et al. 2007, Mars. A new core-crystallization regime. Science 316, 1323-1325.
Hauck et al. 2013. The curious case of Mercury's internal structure. JGR 118, 1204–1220.
Toplis et al. 2013. Chondritic models of 4 Vesta: Implications for geochemical and geophysical properties. MPS 48, 2300-2315.
Khan et al. 2018. A geophysical perspective on the bulk composition of Mars. JGR 123, 575–611.
Trønnes 2019 Core formation, mantle differentiation and core-mantle interaction within Earth and the terrestrial planets. Tectonophys.760, 165-198.
Xia et al. 2019. The effect of core segregation on the Cu and Zn isotope composition of the silicate Moon. GPL12,12-17.

3g. Geodynamo evolution and inner core growth

Bono et al. 2020, Young inner core inferred from Ediacaran ultra-low geomagnetic field intensity, Nat. Geosci., 12, 143-147.
Davies et al. 2022. Dynamo constraints on the long-term evolution of Earth's magnetic field strength. Geophys. J. Int. 228, 316-336.
Landeau et al. 2022. Sustaining Earth's magnetic dynamo. Nat. Rev. Earth Env. 3, 255-269.

3h. Inner core sub- to super-rotation

Song & Richards, 1996. Seismological evidence for differential rotation of the Earth's inner core. Nature 382, 221-224.
Buffett & Glatzmaier, 2000. Gravitational braking of inner-core rotation in geodynamo simulations. Geophys. Res. Lett. 27, 3125-3128.
Yang & Song 2023. Multidecadal variation of the Earth's inner-core rotation, Nat. Geosci., 16, 182-187.

4. Mantle structure, mineralogy and seismology

4a. Lower mantle phase relations: peridotite

Hernlund et al. 2005, A doubling of the post-perovskite phase boundary and structure of the Earth's lowermost mantle. Nature 434, 882-886 (with News & Views-item by Wysession & Solomatov)
Stixrude L, Lithgow-Bertelloni C (2011) Thermodynamics of mantle minerals – II. Phase equilibria. Geophys J Int 184, 1180-1213
Stixrude L, Lithgow-Bertelloni C (2012) Geophysics of chemical heterogeneity in the mantle. Ann Rev Earth Plant Sci 40, 569-595

4b. Lower mantle phase relations: basalt

Hirose K, Takafuji N, Sata N, Ohishi Y (2005) Phase transition and density of subducted MORB crust in the lower mantle. Earth Planet Sci Lett 237:239–25
Stixrude L, Lithgow-Bertelloni C (2011) Thermodynamics of mantle minerals – II. Phase equilibria. Geophys J Int 184, 1180-1213
Stixrude L, Lithgow-Bertelloni C (2012) Geophysics of chemical heterogeneity in the mantle. Ann Rev Earth Plant Sci 40, 569-595

4c. The Fe-spin state of ferropericlase and its seismic expression

Shephard et al. 2021, Seismological expression of the iron spin crossover in ferropericlase in the Earth's lower mantle. Nat. Comm. 12, 5905.
Kennett (2021) The relative behaviour of bulk and shear modulus as an indicator of the iron spin transition in the lower mantle. EPSL 559, 116808.
Wentzcovitch et al. (2009) Anomalous compressibility of ferropericlase throughout the iron spin cross-over. Proc. Natl. Acad. Sci.106 (21), 8447–8452.
Valencia-Cardona et al. (2017) Influence of the iron spin crossover in ferropericlase on the lower mantle geotherm. GRL 44, 4863–4871.

4d. The controversy of Fe-spin state of bridgmanite

Fujino et al. (2012) Spin transition of ferric iron in Al-bearing Mg-perovskite up to 200 GPa and its implication for the lower mantle. EPSL 317–318, 407–412.
Fujino et al. (2014) Spin transition, substitution, and partitioning of iron in lower mantle minerals. PEPI 228, 186–191.
Hsu et al. (2012) Spin crossover of iron in aluminous $MgSiO_3$ perovskite and post-perovskite. EPSL 359-360, 34-39.
Lin et al. (2016) High spin Fe^{2+} and Fe^{3+} in single-crystal aluminous bridgmanite in the lower mantle. GRL 43, 6952–6959.
Mohn & Trønnes (2016) Iron spin state and site distribution in $FeAlO_3$-bearing bridgmanite. EPSL 440, 178–186.
Mao et al. (2017) Equation of state and hyperfine parameters of high-spin bridgmanite in the Earth's lower mantle by synchrotron X-ray diffraction and Mössbauer spectroscopy. Am. Mineral. 102, 357-368.

4e. Seismic structure, upper mantle to uppermost lower mantle

Waszek et al. 2018. Global observations of reflectors in the mid-mantle with implications for mantle structure and dynamics. Nat. Comm. 9, 385.
Waszek et al. 2021. A poorly mixed mantle transition zone and its thermal state inferred from seismic waves. Nat. Geosci. 14, 949–955.

4f. Seismic structure, lowermost mantle

Koelemeijer et al. (2018) Constraints on the presence of post-perovskite in Earth's lowermost mantle from tomographic-geodynamic model comparisons. EPSL 494, 226–238.
McNamara 2019. A review of large low shear velocity provinces and ultra low velocity zones. Tectonophys. 760, 199-220.
Robson et al. 2022. An analysis of core–mantle boundary Stoneley mode sensitivity and sources of uncertainty. Geophys. J. Int. 228, 1962–1974.

5. Mineral diffusivity, mantle viscosity, slab sinking, lithosphere-asthenosphere division

5a. Low diffusivity of of garnet and slow pyroxene dissolution rate in the transition zone

van Mierlo et al. 2013. Stagnation of subducting slabs in the transition zone due to slow diffusion in majoritic garnet. Nat. Geosci. 6, 400-4003.
Shiraishi et al. 2008. Crystallographic preferred orientation of akimotoite and seismic anisotropy of Tonga slab. Nature 455, 657-660.

5b. Diffusion rates of bridgmanite, ferropericlase and post-bridgmanite (post-perovskite)

Holzapfel et al. 2005. Fe-Mg interdiffusion in (Mg,Fe)SiO_3 perovskite and lower mantle re-equilibration. Science 309, 1707-1710.
Holzapfel et al. 2003. Effect of pressure on Fe–Mg interdiffusion in (Fe_xMg_{1-x})O, ferropericlase. PEPI
Amman et al. 2010. First-principles constraints on diffusion in lower-mantle minerals and a weak D″ layer. Nat. 465, 462–465.

5c. Lower mantle rheology: strain weakening and shear localisation??

Girard et al. 2016: Shear deformation of bridgmanite and magnesiowüstite aggregates at lower mantle conditions. Sci. 351, 144-147.
Chen 2019. Lower-mantle materials under pressure Sci. 351, 122-123.
Dobson et al. 2019. Anisotropic diffusion creep in postperovskite provides a new model for deformation at the core-mantle boundary. PNAS 116, 26389–26393.
Cordier et al. 2023, Periclase deforms more slowly than bridgmanite under mantle conditions. Nat. 613, 303-307.

5d. Viscosity structure of the lower mantle and slab stagnation

French, S. W., B. Romanowicz (2015), Broad plumes rooted at the base of the Earth'smantle beneath major hotspots, Nature, 525, 95-99.
Fukao, Y., M. Obayashi (2013), Subducted slabs stagnant above, penetrating through, and trapped below the 660 km discontinuity. Journal of Geophysical Research, 118, 5920–5938.
Marquardt, H., and L. Miyagi, Slab stagnation in the shallow lower mantle linked to an increase in mantle viscosity, *Nature Geoscience*, 8, 311-314.
Rudolph, M. L., V. Lekic, C. Lithgow-Bertelloni (2015), Viscosity jump in Earth's mid-mantle, Science, 350, 1349-1352.

5e. The effect of phase transitions on slab sinking and plume flow through the transition zone

Jenkins J., Cottaar S, White RS, Deuss A, 2016: Depressed mantle discontinuities beneath Iceland: Evidence of a garnet controlled 660 km discontinuity? Earth Planet. Sci. Lett. 433, 159-168.
King, S. D., D. J. Frost, D. C. Rubie (2015), Why cold slabs stagnate in the transition zone, *Geology*, 43, 231–234.
van Mierlo, W.L., Langenhorst, F., Frost, D.J., Rubie, D.C., 2013, Stagnation of subducting slabs in the transition zone due to slow diffusion in majoritic garnet: Nature Geoscience 6, 400–403.
Hirose, K., 2002. Phase transitions in pyrolitic mantle around 670-km depth: impli-cations for upwelling of plumes from the lower mantle. J.Geophys. Res., Solid Earth (1978–2012)107 (B4), ECV-3.
Wada I, King S, 2015. Dynamics of subducting slabs: numerical modeling and constraints from seismology, geoid, topography, geochemistry, and petrology. Treat. Geophys. 7-09, 339-391.

5f. Lithosphere-asthenosphere transition: effects of H_2O, CO_2 and partial melting

Green DH, Hibberson WO, Kovacs I, Rosenthal A (2010) Water and its influence on the lithosphere–asthenosphere boundary. Nature 467, 448-451
Lee, C-T A, Luffu P, Chin EJ (2011) Building and Destroying Continental Mantle. Annu Rev Earth Planet Sci 39-59-90.
Mierdel K, Keppler H, Smyth JR, Langenhorst F (2007) Water solubility in aluminousorthopyroxene and the origin of Earth's asthenosphere. Science 315, 364-368
Peslier AH, Woodland AB, Bell DR, Lazarov M (2010) Olivine water contents in the continental lithosphere and the longevity of cratons. Nature 467, 78-81.
Shirey SB et al. (2012) Diamonds and the Geology of Mantle Carbon. Rev Mineral Geochem 75, 355-421.

6. D"-structure, large-scale planetary mass distribution and convection

6a. Structure and dynamics of the D" zone

van der Hilst et al. 2007. Seismostratigraphy and thermal structure of Earth's core-mantle boundary region. Science 315, 1813-1817.
Lay 2015. Deep Earth structure: lower mantle and D". Treat. Geophys. 1-22 683-723.
Lekic et al. 2012. Cluster analysis of global lower mantle tomography: A new class of structure and implications for chemical heterogeneity. EPSL, 357, 68–77.
Trønnes 2019, Core formation, mantle differentiation and core-mantle interaction within Earth and the terrestrial planets. Tectonophys. 760, 165-198.

6b. The residual geoid, free air gravity and excess LLSVP mass

Hager et al. 1985. Lower mantle heterogeneity, dynamic topography and the geoid, Nature, 313, 541–545.
Ishii & Tromp 1999. Normal-mode and free-air gravity constraints on lateral variations in velocity and density of Earth's mantle. Sci. 285, 1231–1236.
Steinberger & Torsvik, 2010, Toward an explanation for the present and past locations of the poles. Geochem Geophys Geosyst doi:10.1029/2009GC002889
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6c. Terrestrial planetary gravity field and topography

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