# “So Many Millimetres a Year” Is Not a Speed but a Supply Divided by a Cross-Section

— At one drip a minute, **0.05** mL a drip and **150** mg/L deposited, the supply of calcium carbonate is **3.945** g a year, or **1.4556** cm³ a year — the separator is whether the supply changed or the thickness did — [Paper 817]

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— *From thinking to syncing.* —

**Abstract**

**The growth of a stalactite is quoted as a number like “0.1 millimetres a year”.This paper counts what division that number is made of, separating supply from shape.No new theorem or law is claimed. First, the supply can be counted as a volume——one drip a minute at 0.05 mL with 150 mg/L deposited gives 26.298 L of water, 3.945 g of calcium carbonate and 1.4556 cm³ a year** (Section 2). **Second, and this is the core. The speed is that supply divided by the cross-section——the same supply gives 18.533388 mm/yr at a radius of 0.5 cm and 1.158337 at 2 cm, a ratio of exactly 16.000000, the inverse of the cross-section** (Section 3). **Third, changing the supply changes the speed in proportion——3.706678 mm/yr at 0.2 drips a minute and 92.666938 at 5** (Section 3). **Fourth, the observed rate is a small part of that bound——0.1 mm/yr is 0.005396 of the 18.533388 mm/yr bound at 0.5 cm, so 0.5396 percent of the supply stays at the tip** (Section 4). **Fifth, so “how many years” is undecided until the shape is given——one metre takes 54 years at the bound and 10000 years at the observed rate** (Section 4). **Sixth, the separator is whether the supply changed or the thickness did——the same “millimetres a year” means different things depending on which** (Section 5). **Keywords**: stalactite, deposition, supply, cross-section, growth rate, representative values.

**Scope of this paper (scope note)**: **No new theorem or law is claimed——that stalactites grow by deposition of calcium carbonate, and that the growth is proportional to supply and inverse to cross-section, are known.The values are representative——one drip a minute, 0.05 mL a drip, 150 mg/L deposited and an observed 0.1 mm/yr all vary greatly between caves.No real cave is claimed——neither the age nor the growth rate of any particular place is treated.The chemistry is not entered——carbonate equilibria, degassing rates and the effects of temperature and carbon dioxide pressure are not the subject.The shape is simplified——the tip is taken as a circle of fixed radius; soda straws and the thickening process are not treated.Dating is not treated——procedures such as uranium-series dating are not entered.Relation to earlier papers**: **Paper 326 showed that the square-cube "law" is an identity, not a law——this paper stands beside it: "millimetres a year" is likewise not a law to be measured but a supply divided by a cross-section.Paper 300 showed that whether two things share a root is decidable——a change of supply and a change of thickness are distinct roots behind the same number.**What is added is **counting the supply as 1.4556 cm³ a year**, **confirming the inverse-cross-section dependence at exactly 16.000000**, **measuring the observed rate as 0.005396 of the bound and inferring the fraction that stays at the tip**, and **placing the separator on supply versus thickness**.

## 1. Notation and the Question

**Setting**: **water falling from the ceiling leaves calcium carbonate behind and the tip grows.Writing $V$ for the supplied volume (cm³ a year), $r$ for the radius of the tip and $v$ for the growth, all of the supply staying at the tip gives**

$$v = \frac{V}{\pi r^2}$$

**One drip a minute, 0.05 mL a drip, 150 mg/L of calcium carbonate deposited and a density of 2.71 g/cm³ are taken as representative values.**

**Question**: **what division is the number "millimetres a year" made of?**

## 2. Counting the Supply

**Computation 2.1**: **a year of supply was converted into a volume.**

| quantity | value |
|---|---|
| water | **26.298** L a year |
| calcium carbonate | **3.945** g a year |
| volume | **1.4556** cm³ a year |

> **Observation 2.2**
>
> the supply knows nothing of the shape.It is fixed by the drip rate and the concentration alone, with no thickness in it——shape enters only when this volume is turned into a height.

## 3. Dividing by the Cross-Section

**Computation 3.1**: with the supply held fixed, only the radius of the tip was changed.

| radius (cm) | cross-section (cm²) | growth (mm/yr) | years for 1 m |
|---|---|---|---|
| 0.25 | 0.1963 | 74.133550 | 13 |
| 0.5 | 0.7854 | 18.533388 | 54 |
| 1.0 | 3.1416 | 4.633347 | 216 |
| 2.0 | 12.5664 | 1.158337 | 863 |
| 5.0 | 78.5398 | 0.185334 | 5396 |

> **Observation 3.2**
>
> this is the core. The speed is the supply divided by the cross-section.Four times the radius gives one 16.000000th of the speed, exactly the inverse ratio of the cross-sections——a thick stalactite is slow not because its growth is sluggish but because the same amount is spread over a wider face.

**Computation 3.3**: with the radius fixed at 0.5 cm, only the drip rate was changed.

| drips a minute | growth (mm/yr) |
|---|---|
| 0.2 | 3.706678 |
| 1.0 | 18.533388 |
| 5.0 | 92.666938 |

> **Observation 3.4**
>
> **the supply enters in proportion.Five times the drips gives five times the speed——the same “millimetres a year” can mean more water or a thinner tip.**

## 4. Comparing With the Observed Rate

**Computation 4.1**: **the bound with all of the supply staying at the tip was set beside the representative observed rate.**

| quantity | value | years for 1 m |
|---|---|---|
| bound (radius 0.5 cm) | 18.533388 mm/yr | 54 |
| representative observed | 0.1 mm/yr | 10000 |
| ratio | 0.005396 | — |

> **Observation 4.2**
>
> **the observed rate is a small part of the bound.It is 0.005396 of it, so 0.5396 percent of the supply stays at the tip and the rest goes to the floor and the walls——“0.1 millimetres a year” carries this share as well as the supply and the shape.**

> **Observation 4.3**
>
> **so the years are undecided until the shape is given.One metre takes 54 years at the bound and 10000 years at the observed rate——“a metre is ten thousand years” is not a clock of the cave but a product of supply, shape and share.**

## 5. The Separator

**Observation 5.1**

**the separator is whether the supply changed or the thickness did.Five times the drips and a radius smaller by $\sqrt{5}$ raise the speed by the same factor——the number alone does not say which happened.**

**Observation 5.2**

**placed beside Papers 326 and 300.Paper 326 showed that the square-cube “law” is an identity——here too “millimetres a year” is a value of a division, not a law.Paper 300 showed that sharing a root is decidable——supply and shape are distinct roots behind one number.**

**Observation 5.3**

**what is not said.The age of any real cave, the chemistry of carbonate, the shape of soda straws and dating procedures are not treated——what is shown is that the speed is a supply divided by a cross-section.**

## 6. Census and Closing

1. **water 26.298 L a year** (Computation 2.1): **from the drip rate.**
2. **calcium carbonate 3.945 g a year** (Computation 2.1): **from the concentration.**
3. **volume 1.4556 cm³ a year** (Computation 2.1): **a quantity blind to shape.**
4. **18.533388 mm/yr at 0.5 cm** (Computation 3.1): **the bound.**
5. **1.158337 mm/yr at 2 cm** (Computation 3.1): **same supply.**
6. **ratio 16.000000** (Observation 3.2): **the core; inverse cross-section.**
7. **92.666938 mm/yr at five times the drips** (Computation 3.3): **proportional to supply.**
8. **observed 0.1 mm/yr** (Computation 4.1): **0.005396 of the bound.**
9. **54 years against 10000 for 1 m** (Observation 4.3): **shape decides.**
10. **supply or thickness** (Observation 5.1): **the separator; Papers 326, 300.**

**Closing**: **“So many millimetres a year” is not a speed but a supply divided by a cross-section.One drip a minute at 0.05 mL with 150 mg/L deposited gives 1.4556 cm³ a year, and if all of it stayed at the tip that would be 18.533388 mm/yr at a radius of 0.5 cm and 1.158337 at 2 cm, a ratio of exactly 16.000000——the same amount spread over a wider face rises less.The representative observed 0.1 mm/yr is only 0.005396 of that bound, so 0.5396 percent of the supply stays at the tip, and one metre takes 54 years at the bound against 10000 years as observed——the rest goes to the floor and the walls.Changing only the drip rate changes the speed in proportion (3.706678 at 0.2 a minute, 92.666938 at 5), and the separator is whether the supply changed or the thickness did.Placed among the earlier papers——standing beside Paper 326’s “identity, not a law”, and keeping Paper 300’s discipline in treating supply and shape as distinct roots.To be honest——every value used is representative, and neither the age of a real cave nor the rate of the chemistry is treated.**

## References


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