
Time Kirchhoff Migration
TIKIM

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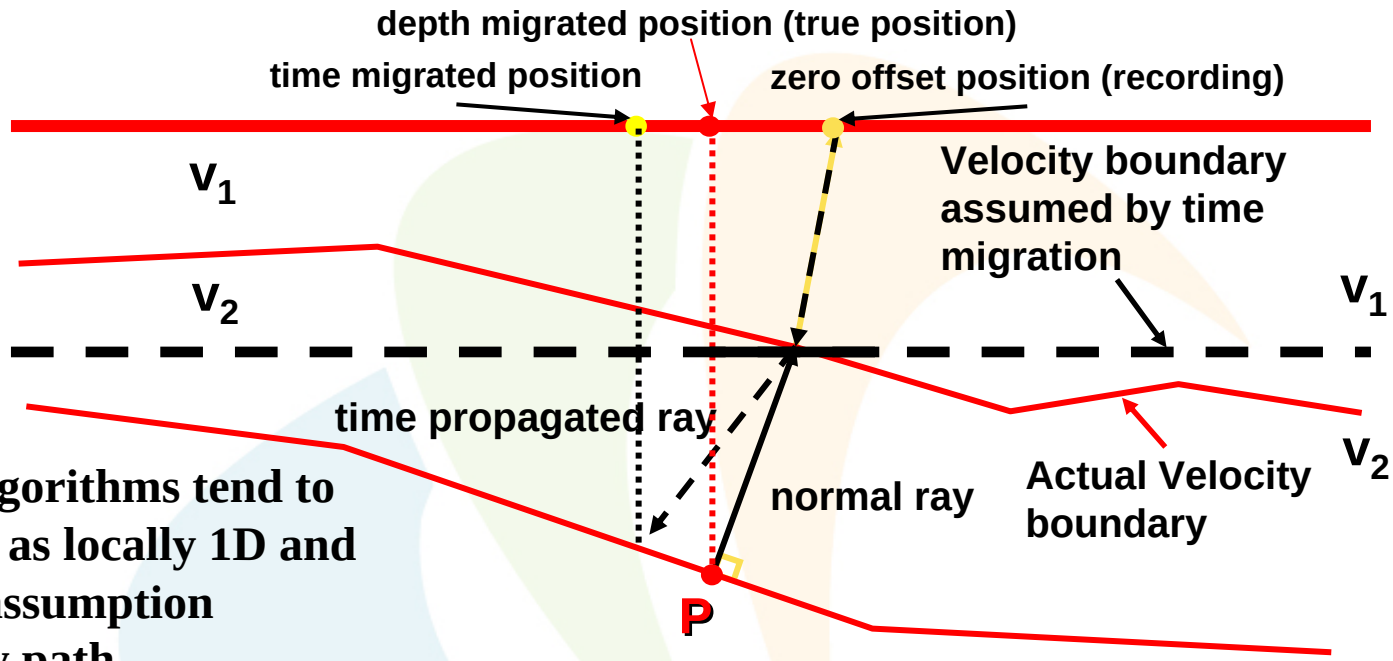
Part 1

Time versus Depth

Limited velocity field complexity in PSTM

Time migrations assume Velocity Boundaries are *always* flat and *infinitely* long..



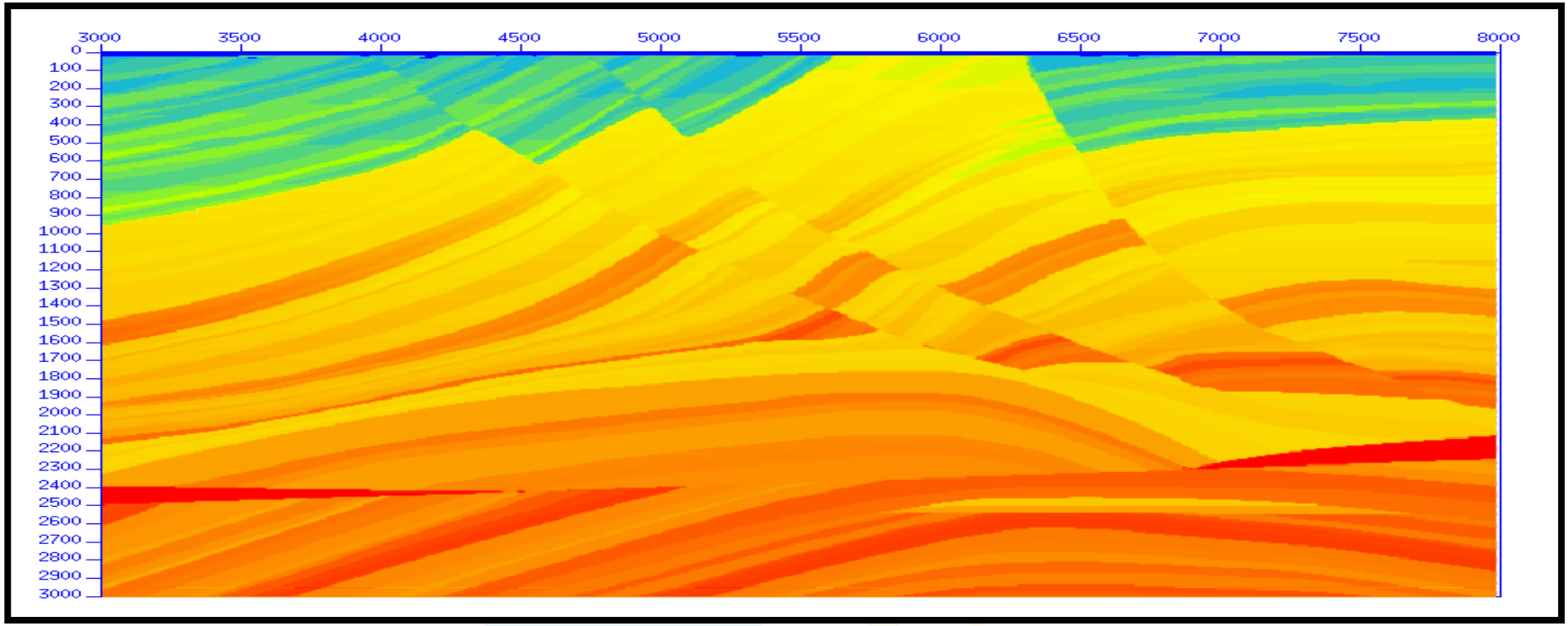
Time migration algorithms tend to treat velocity field as locally 1D and will make wrong assumption concerning the ray path.

Essentially, the velocity model seen by time migrations at any location will be composed of perfectly flat layer cake velocity layers, no matter what the actual structure is.

For steep dips this can lead to severe mis-positioning of the reflectors (even on relatively flat reflectors lying below steep dips!).

Highly complex velocity model

- Consider a model with serious lateral velocity variations



Both the structure and the velocity regime are complex

- **– the stacked trace is not a zero-offset trace**
- **– for correct imaging pre-stack Depth Migration must used**

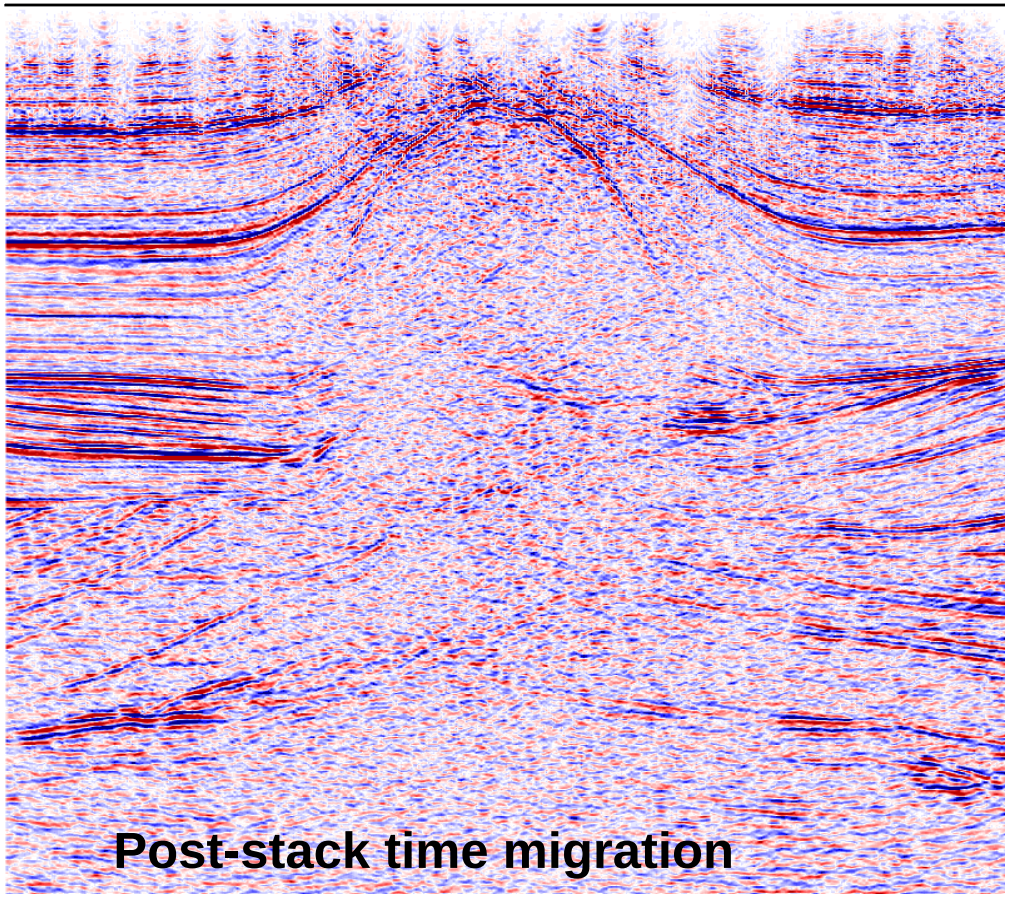
Time Migration versus Depth Migration

- **time migration is a focusing problem *(kinematics)***
  - ✓ **preserves flat time events**
  - ✓ **positions dipping events in a sound geological way**
  - ✓ **robust process**

- **depth migration is a positioning problem *(modeling)***
  - ✓ **positions events laterally *and* vertically**
  - ✓ **handles complex geological structure**
  - ✓ **highly sensitive to velocities**

Post Stack Time vs. Pre stack Depth Migration

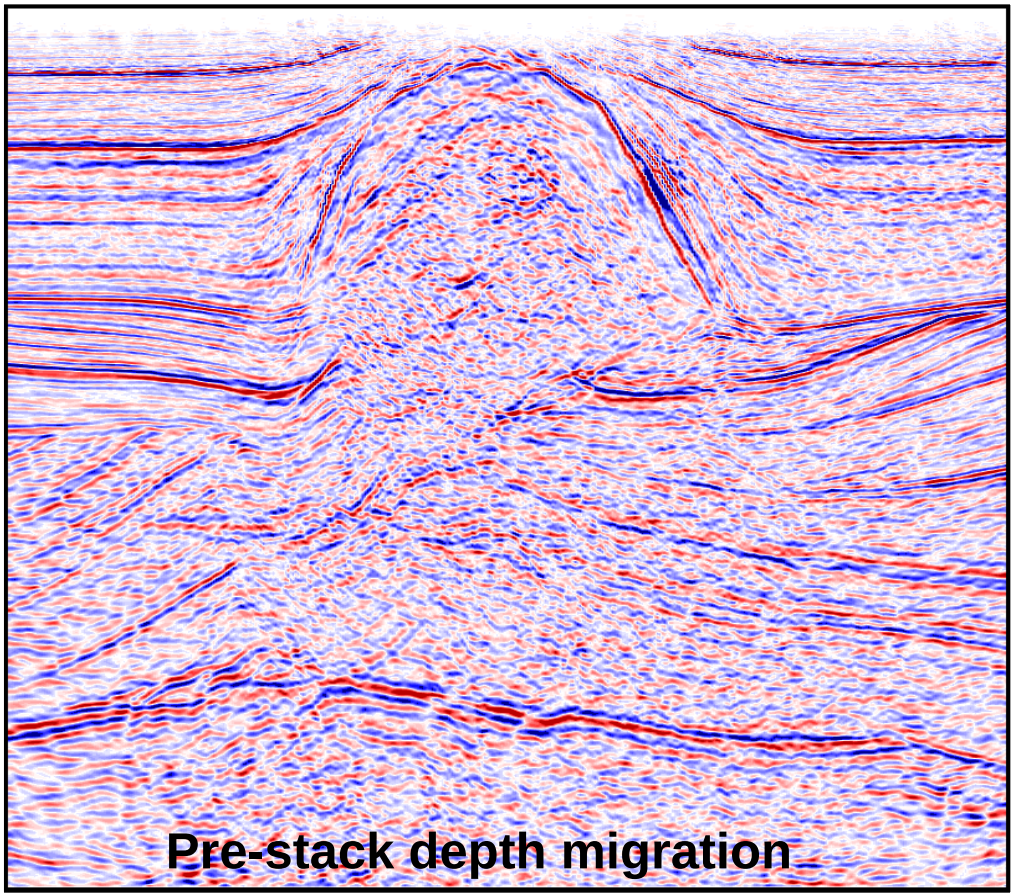
Post-stack time and pre-stack depth migrations….



Post-stack time migration

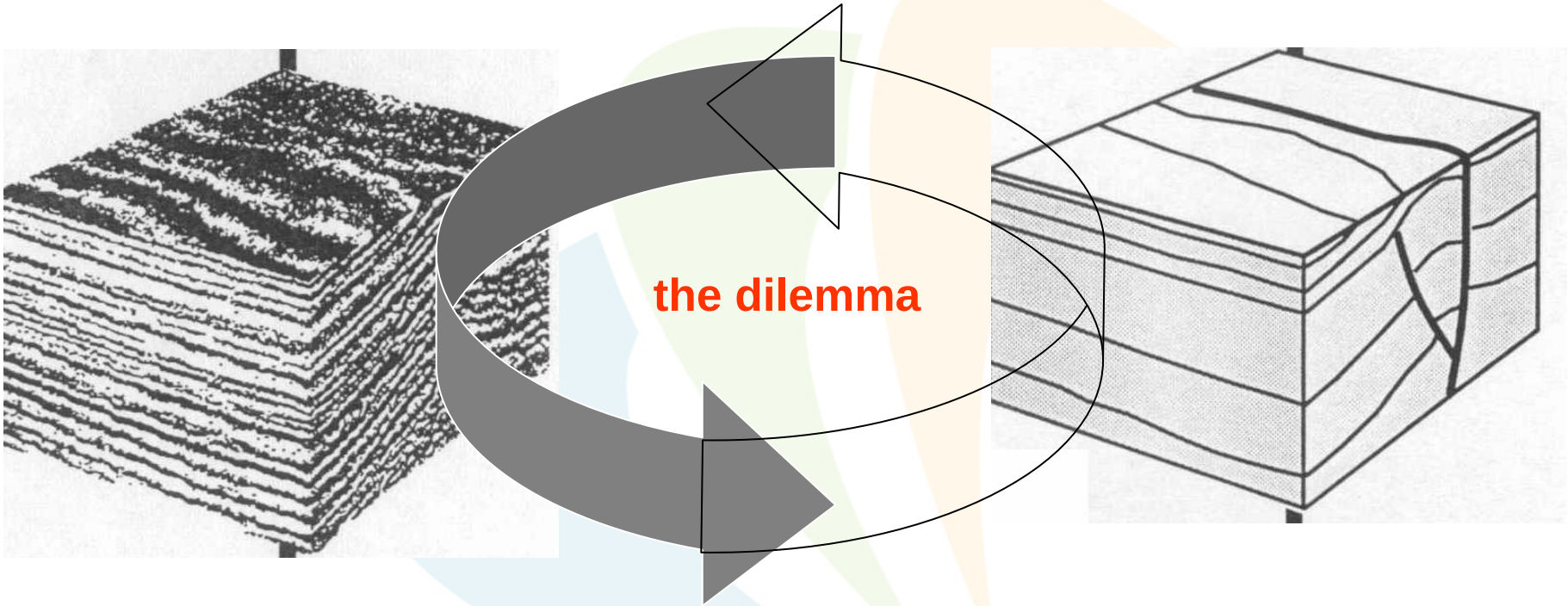
Post Stack Time vs. Pre stack Depth Migration

Post-stack time and pre-stack depth migrations.



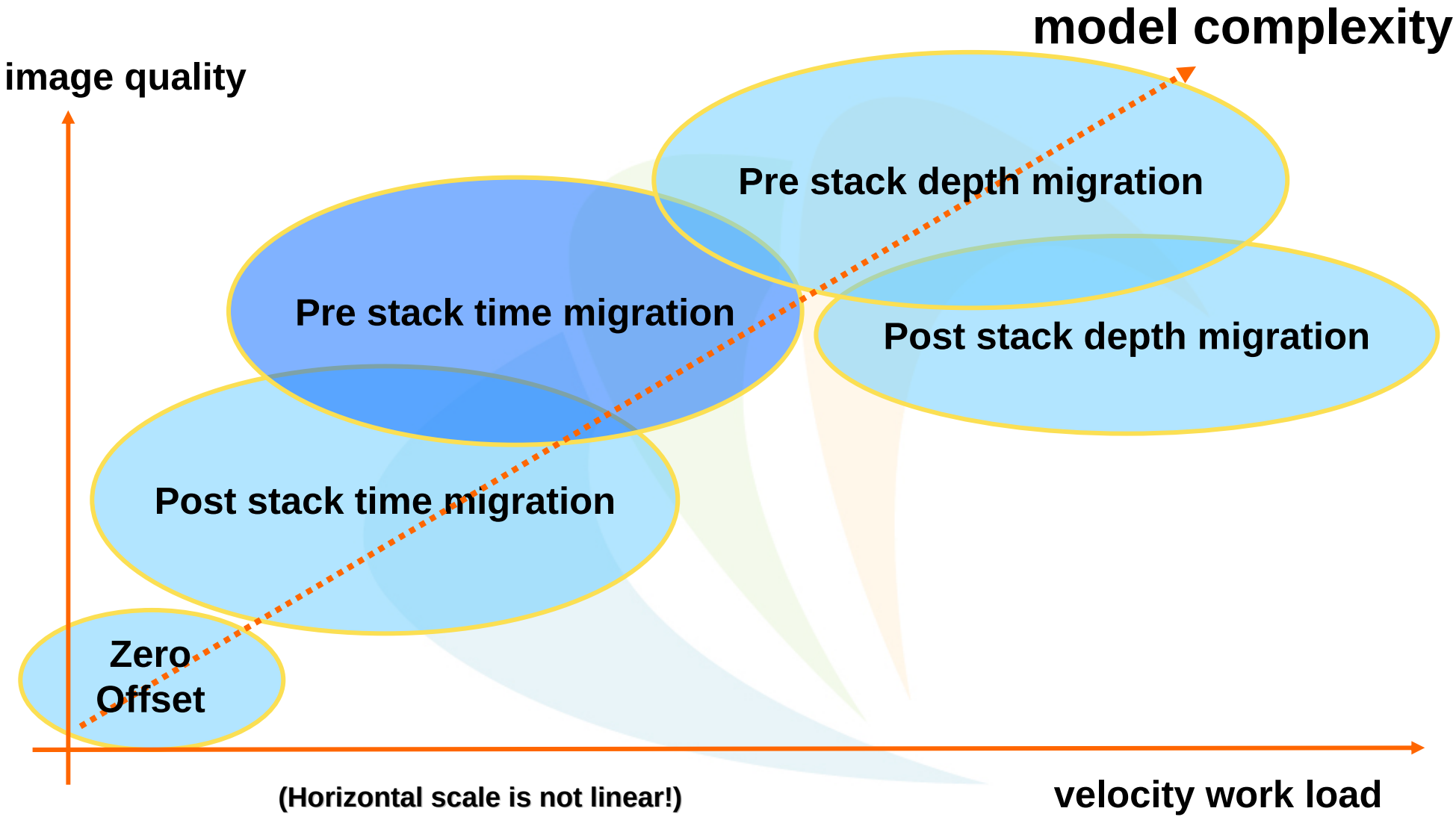
Depth Imaging Dilemma

Depth imaging requires knowledge of the model…



…knowledge of the model requires depth imaging

Time and Depth: Quality versus Velocity Workload



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Summary of Time imaging vs. Depth imaging

	Time imaging	Depth imaging
Travel times	hyperbolic assumption	modelled rays
Velocity field	RMS Velocities	Interval Velocities
Apply to	laterally smooth media	any media
Sensitivity to velocity model	Average to high	High

Summary

- In simple earth models wave fronts are hyperbolic
- Realistic earth models engender non-hyperbolic behaviour
  - data will require migration in time and space

- Method chosen might be related to:
  - geophysical objective (i.e. exploration reconnaissance vs. reservoir development)
  - velocity and / or structural complexity
  - the processing turnaround time available / budget

- TIKIM is considered ‘state of the art’ PreSTM.

Part 2

Introduction to TIKIM

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The Zero Offset Situation

- Zero-offset data would include:

  Post-stack data

  Prestack offset volumes (offset cubes) after NMO (and DMO)

If we are processing zero offset cube volumes, there is no difference between pre-stack techniques and post-stack techniques

Finite offest

Zero-offset does not include offset volumes without NMO and DMO

TIKIM approach includes finite offset volumes and is a full preSTM

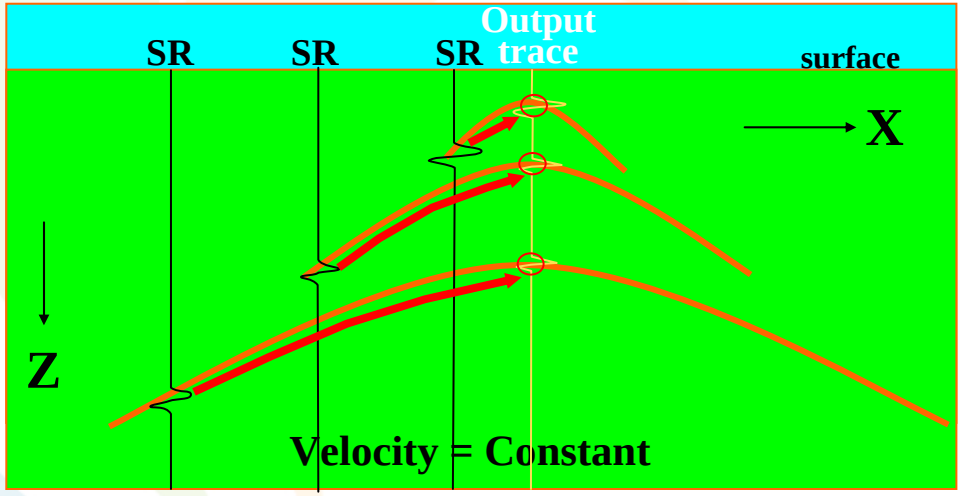
Time Model: source-receiver non-zero

- Effectively, we are combining NMO, DMO, Migration onto a single operator for each offset class
- Which algorithm can we use?
  - Both f-k and finite difference migration are only applicable to zero offset data: full migration would have to be split into two phases (also velocity limitations for f-k)
  - Kirchhoff migration can be modified to include an offset term, hence it is readily adapted for use in one-pass preSTM

unmigrated to migrated time mapping

TIKIM employs a Kirchhoff algorithm generically described as a trace-by-trace Diffraction Summation Method.

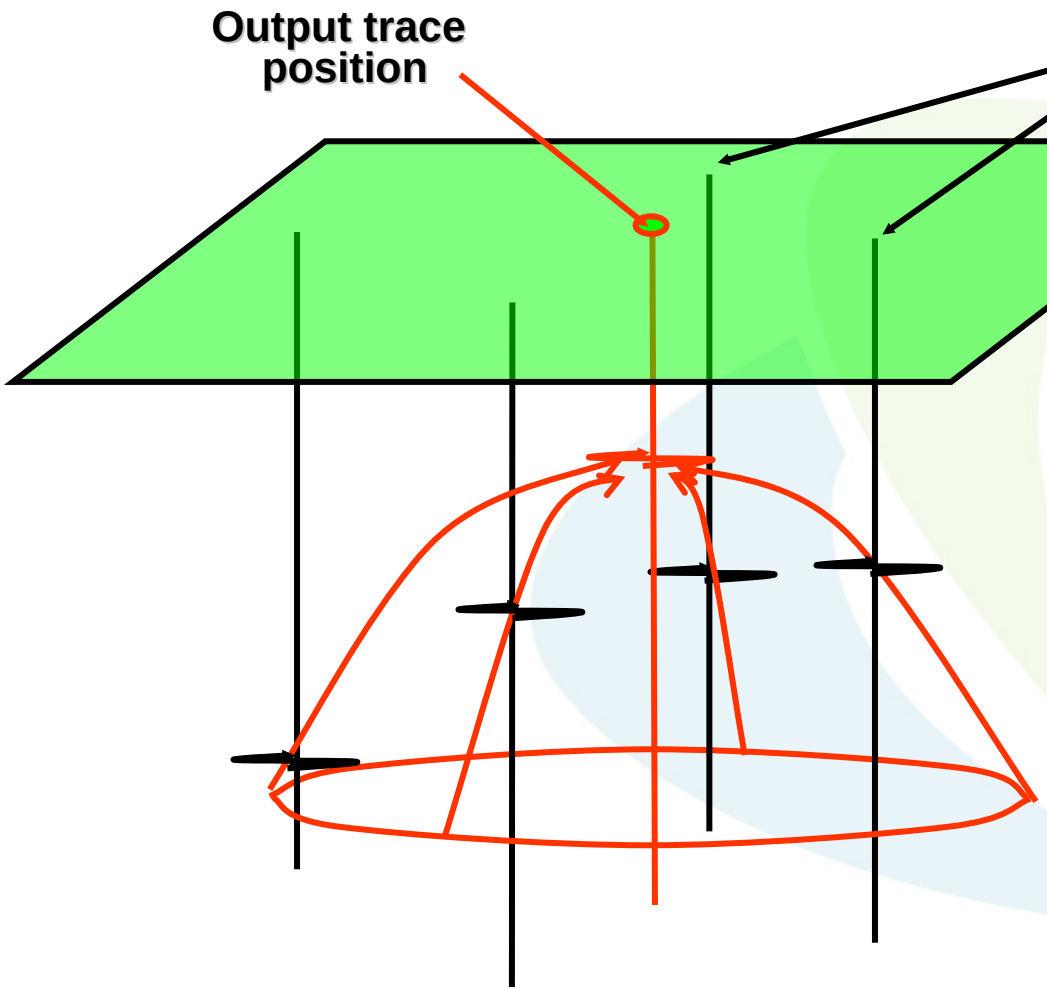
Output samples are reported as if at the apex of a diffraction curve and result from the summation of amplitudes which have been extrapolated along a hyperbolic trajectory defined by a locally defined V_{RMS} field



The final reflector image results from constructive interference

TIKIM : Hyperbolic assumption – 3D

TIKIM works using a trace by trace Kirchhoff migration algorithm.



Each OUTPUT sample is generated by assuming it to be at the apex of a diffraction hyperbola.

Input samples are collected from along the diffraction hyperbola.

The shape of the diffraction hyperbola is determined by the local V_{rms} value

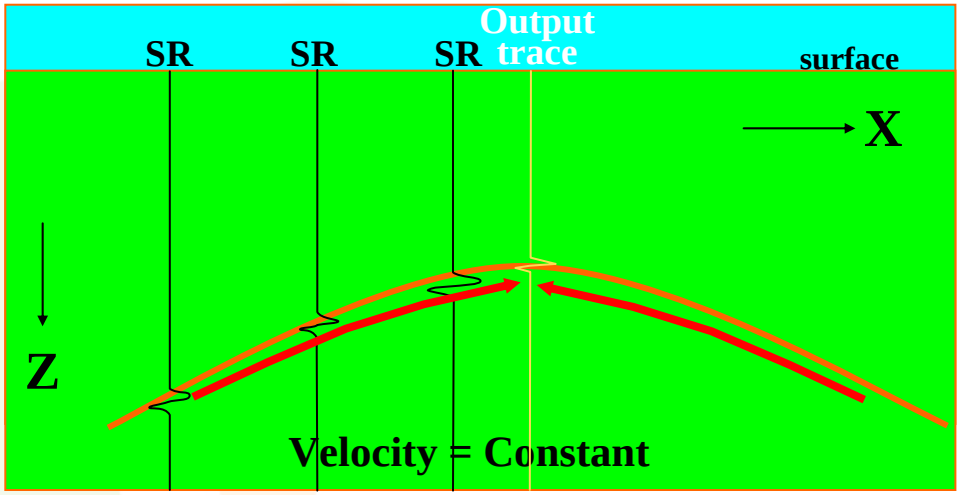
‘Stacking’ in TIKIM

There are two ‘stacks that occur in TIKIM

‘First stack’

Each output trace is created by stacking the samples ‘collected from along the hyperbolic surfaces.

This is done separately for each output offset class trace.

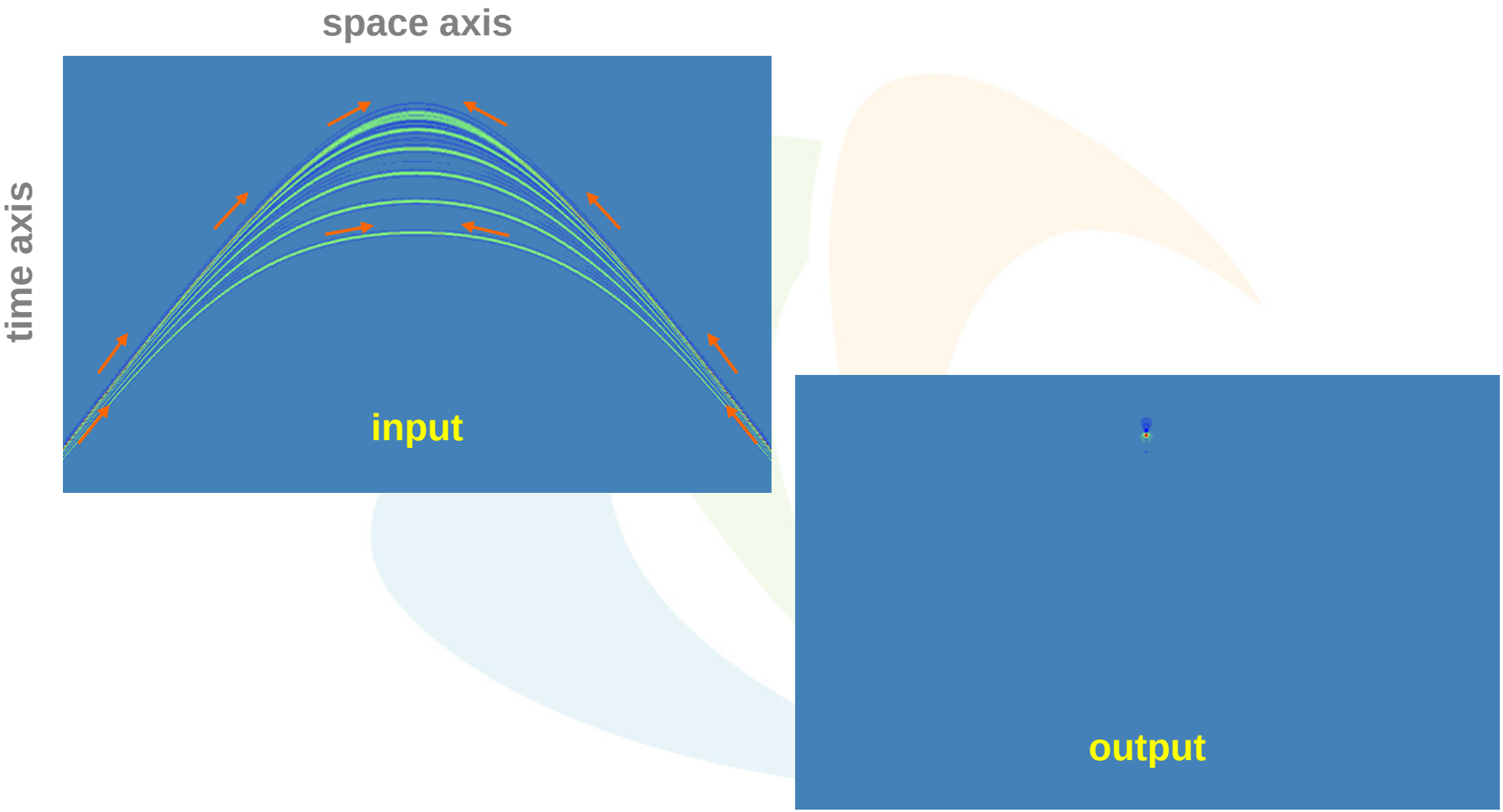


Optionally the created traces can be output individually as ‘image bin gathers’

‘Second stack’

The offset class traces for each bin can be stacked to provide a migrated stack output.

Full Kirchhoff PSTM – TIKIM



Full Kirchhoff PSTM - TIKIM

- TIKIM Technology allows:
  - Velocity analysis in migrated domain
  - NMO, DMO & PSTM in One Step
  - Full PSTM
  - AVO Attributes: Quick to Produce